BULLETIN 617 DECEMBER, 1940

PROGRESS

OF

AGRICULTURAL RESEARCH

IN

OHIO

1938 - 1939

FIFTY-EIGHTH ANNUAL REPORT
OF THE
OHIO AGRICULTURAL EXPERIMENT STATION
WOOSTER, OHIO
FOR THE YEAR ENDING JUNE 30, 1939

This bulletin is planned to give you a picture of the work being carried on by your Ohio Experiment Station in the interest of Ohio's agriculture.

If you would like more special information on any agricultural problem, write or come to the Experiment Station. The workers here are always ready to help you.

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The Honorable Lockwood Thompson
President of the Board of Control
Ohio Agricultural Experiment Station

Dear Sir:

I have the honor to present to the Board of Control for transmission to the Governor of Ohio, as required by law, the fifty-eighth annual report of the Ohio Agricultural Experiment Station for the year ended June 30, 1939.

Edmund Secrest
Director

The Honorable John W. Bricker
Governor of Ohio

Dear Sir:

I have the honor to present to you the fifty-eighth annual report of the Ohio Agricultural Experiment Station for the year ended June 30, 1939.

Lockwood Thompson
President, Board of Control

PROGRESS OF AGRICULTURAL RESEARCH IN OHIO

Established by legislative action in 1882 as a department of the State Government, the Ohio Agricultural Experiment Station has as its purpose, to develop the agricultural industry of Ohio and to solve the multitude of problems that continually beset this industry.

Since it is agriculture that feeds and clothes the Nation, any problem of agriculture is a problem of society as a whole. Through its projects, therefore, the Experiment Station serves every person in the State; the farmer directly, and through him, the city dweller.

To meet the demand for high-yielding corn that will grow well under Ohio conditions, plant breeders are constantly at work developing new hybrid strains. This year they will release 40 for farm trial. Soybean varieties that will fulfill the requirements for a profitable crop in Ohio are under investigation too. To increase the value of the soil-conserving grasslands to Ohio farmers, agronomists have developed ways to improve their pastures and pasture crops.

Through the effort of Experiment Station horticulturists, Ohio fruit and vegetable growers know how they can secure the best yields and highest food value from their orchard, garden, and greenhouse crops. As a result of Experiment Station research, there are new fruit and vegetable varieties available for Ohio growers.

Without protection from disease and insect pests, however, even the most favorable growing conditions and high-yielding varieties of crops might be of little value. To provide such protection, research workers have developed fungicides and insecticides, as well as new plant varieties that resist insect and disease attack.

Milk is sometimes called the most nearly perfect food. To ensure that consumers receive their milk and other dairy foods as near this mark as possible and that the dairyman can produce his products economically and satisfactorily, is the aim of Experiment Station dairy research workers. They have devised ways of increasing production, as well as new feeds and management practices that enhance the food value of dairy products.

Feed is a constant problem for the man who raises livestock and poultry, and to help him solve this problem, Experiment Station workers study both feeds and animals in order to develop the rations on which different farm animals will produce best. Animal diseases, an ever-present threat of loss to the livestock man, are being brought under control by newly developed methods of prevention and treatment.

Most growers store crops on their farms. If these stored crops are to remain usable, and not be lost, farmers must know how satisfactory storage places can be constructed for them. Agricultural engineers have devised such farm structures.

Farming is a business. A farmer's effort in producing even the best crops and animals has gone for little if he does not manage his enterprise so that he secures a satisfactory return for his work. Information to help the farmer in his marketing transactions and in his tenant relationships has come from the research of rural economists.

To supplement its laboratory and field research in the solving of agriculture's problems, the Experiment Station operates 16 branch farms located in different sections of the State, in order to test crops under varying conditions.

The Experiment Station manages 103,000 acres of State forests and forest parks for the people of Ohio and operates two forest nurseries where some 7,000,00 trees are produced and distributed for forest planting. In addition, it protects 1,500,000 acres from forest fire.

SOILS, FIELD CROPS, AND PASTURES

SWEET CLOVER ROTATIONS NEED PLENTY OF POTASH

The 1939 results from the "Sweet Clover Green Manure Experiment" at Wooster show that it is important to maintain the potash supplies in soil carrying rotations that include sweet clover as a green manure. In this experiment, begun in 1930, corn and oats are grown in a 2-year rotation, with and without sweet clover sown in the oats for green manure. Stalk breakage ranging from none to as high as 50 per cent occurred in corn following sweet clover, even though the corn was a stiff-stalked hybrid. The yield of grain also varied widely. These variations appeared to be related to the amounts of potassium found in leaf samples taken about 2 weeks before harvest. Largest yields and least breakage came from plots that received potash fertilizer or straw and stover residues.

Yield and stalk breakage of corn following sweet clover in 1939

Treatment	Potassium in leaves	Stalk breakage	Yield
	Per cent		*Bushels per acre*
RP, L, SC	0.71	Severe*	68.4
RP, ½L, SC	.73	Severe*	70.1
P, L, SC	.93	Medium	71.8
P, L, SC (plowed May 15)	.99	Medium	75.0
PK, L, SC	1.06	Slight	87.8
P, L, SC, straw, stover.	1.50	None	93.6

RP=rock phosphate, 400 lb. annually, L=limestone, 1 ton on corn; SC=sweet clover (plowed down May 1 except plot 8); P=0-20-0, 150 lb. on corn, 250 lb. on oats; PK=0-14-6, 214 lb. on corn, 357 lb. on oats; average amount of straw, 1,625 lb.; average amount of stover, 3,535 lb.

*About 50 per cent.

Deep-rooted legumes like sweet clover and alfalfa take potash from the soil readily. When turned down for green manure, they give up this potash easily to corn and other grain crops, in which it will be found chiefly in the stover or straw. If this stover or straw is not returned to the land, soil potash loss is apt to be accelerated.

WHEAT ROOT STRENGTH GUIDE TO WINTER HARDINESS

Extensive study by Experiment Station wheat specialists shows that size and strength of roots help determine the amount of winter injury done to wheat by heaving. The central core of the root, or "vascular stele," is the important element. Root strength varies greatly with variety and with soil and season. Minhardi, for example, has small weak roots that with normal fall development break under a tension of 250 to 300 grams. Trumbull, under similar conditions, requires 375 to 400 grams. Gladden roots are still stronger, breaking at 500 to 525 grams. The breaking strength of these varieties corresponds closely to their ability to resist heaving.

Soil fertility is important in developing good strong roots during fall growth. On the poorest soil in the "Four Levels of Fertility Experiment" at Wooster, the average breaking strength of roots for seven varieties was about 275 grams. With one increment of fertilizer this average rose to 320 grams; with two increments, to 360 grams; and with four increments, to 420 grams. These figures represent real differences in ability to withstand heaving.

Studies like this help in evaluating new lines in the nursery and indicate the importance of good cultural practices.

FORTY NEW CORN HYBRIDS READY FOR FARM TRIAL

A leap from 1,100 to 1,952,000 acres, or from three-hundredths of 1 per cent of the State's total corn acreage to 57 per cent, describes the phenomenal increase in the planting of corn hybrids in Ohio from 1933 to 1939. This tremendous expansion has come about partly through increased acreages of some of the older certified hybrids, partly through the use of new hybrids, many of them distinctly better than the older ones.

One of the successful new corn hybrids developed at the Ohio Agricultural Experiment Station

In the spring of 1939, seed stock (inbred lines) for 40 new hybrids was released by the Experiment Station[1] to the Ohio Hybrid Seed Corn Producers, who made the necessary foundation crosses in 1939. The commercial seed will be made in 1940. Participating in its production will be more than 200 of the commercial hybrid seed corn producers of the State, each growing three or more new hybrids, carefully chosen to meet conditions of soil, season, and market in his community. Thousands of farmers will be able to see some of these new combinations, both in seed plots and as actual hybrids growing on seed producers' farms, in 1940. These new hybrids range in areas of adaptation from Ashtabula to Hamilton Counties.

Higher yield, less breakage, and less lodging have been given major attention in the selection of the new strains. There is evidence also that greater tolerance to the European corn borer and less susceptibility to aphids, smut, stalk rot, and the recently troublesome leaf blight have been achieved in some of the combinations.

[1]The corn breeding program of the Ohio Agricultural Experiment Station is in cooperation with the U. S. Bureau of Plant Industry.

LACK OF AIR IN SOILS LIMITS SUGAR BEET YIELDS

Studies on the heavy Brookston clay at the Northwestern Experiment Farm at Holgate indicate that lack of enough air for proper root respiration may limit sugar beet yields on such soils. These studies included various treatments, including the incorporation of varying amounts of manure and straw to different depths and the building of ridges of varying height, designed to remove surface water and open up the soil. Laboratory measurements of the amount of noncapillary pore space, that is, the large pores permeable to air and water, showed a direct correlation with growth, final yield, and sugar content of beets.

In spite of a very adverse season, in which some plots without treatment yielded below 2 tons an acre, the best treatments gave up to 15 tons an acre with a sugar content of over 19 per cent. Both green manure crops and barnyard manure, properly used, are believed to offer considerable promise as practical means for achieving the better tilth required for high beet yields on heavy soils.

ALL-SEASON PASTURE SYSTEM RESULT OF EXPERIMENTS

The greatest pasture problem of the livestock farmer in Ohio is the changing quantity and quality of his pasture. Extensive experiments attempting to solve this problem are under way at five Experiment Station farms. These tests show that a combination of different treatments and types of pasture can be developed that gives a more abundant and uniform supply of high-quality pasture from earlier in the spring to later in the fall than commonly available. For example, nitrogen fertilizer on Kentucky bluegrass has advanced the beginning of the grazing period by 2 weeks. A combination of treatment and management has improved the quality and quantity of production from the main pasture area and maintained this production longer into midsummer. Sudan grass, alfalfa and timothy, and alfalfa and orchard grass have provided for July and August and spared the main pasture during this period, making possible, in turn, later fall grazing of the main pasture area. This new system, a result of the experiments carried on, has greatly increased the carrying capacity of the acreage devoted to pasture.

EARLIER SOYBEAN VARIETIES IN DEMAND

More and more Ohio farmers are fitting soybeans into their crop rotations, frequently as the crop preceding wheat. If wheat seedings made after combine-harvesting soybeans are not to be too late, early maturing soybeans must be grown. It is difficult to obtain early soybean seed, especially in northern Ohio, where varieties early enough have been insufficiently tested.

Several early varieties obtained from northern states and foreign countries were tested at three places in northern Ohio in 1939. Among varieties whose seed is available, the most promising were Mandarin, Wisconsin No. 3, and Richland. Agreeing with the previous observation that varieties tend to yield roughly in proportion to their lengths of growing season, these early varieties produced 2.5 to 5.5 bushels less than the highest yielding varieties in each test. Mandarin was earliest and yielded least. Several other early strains appeared promising, but seed is not yet available and further testing is necessary.

DEVISE NEW METHOD TO MEASURE SOIL MOISTURE

For decades, soil scientists have been seeking a method for measuring soil moisture that would not require sampling, drying, and weighing. A new electrothermal method, the outcome of 2 years' research by Station soil physicists, seems to fill the need. It successfully measures soil moisture over a range from complete dryness to saturation and is not affected by salts, temperature changes, or hysteresis influences.

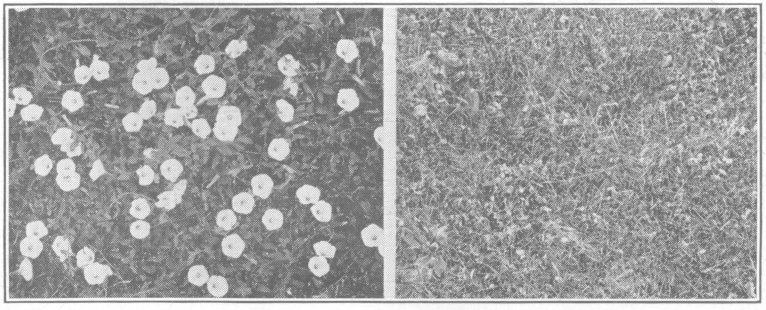
Essentially, the method is based upon the fact that conduction of heat in the soil is dependent upon the amount of soil moisture present. A small coil of copper wire wound upon a glass tube about the size of a lead pencil is inserted into the soil. This coil is heated up by passing a small electric current through it. The temperature of the coil depends upon how fast the heat is conducted away from it, and this rate of conductance depends upon the moisture content of the soil. (Moist soils conduct heat much faster than dry ones.) The resistance of the coil to the passage of electricity increases with the temperature of the wire. By measuring the resistance of the coil with a microammeter, a measure of the amount of soil moisture is obtained.

Experiments have shown that highly accurate readings of soil moisture can be obtained within 1 minute, and readings can be repeated as often as every 20 minutes. It is proposed to make permanent installations of the coils within natural soils and to have the measuring device portable. In this way, a large number of readings can be obtained in a relatively short time.

The method promises to be very useful in research dealing with underground water sources, flood control, soil and water conservation, plant physiology, and irrigation.

FIELD BINDWEED ERADICATED WITH CHLORATE

Although long known in northwestern Ohio, where it apparently was introduced in sugar beet seed, field bindweed was not considered a serious weed until the series of dry seasons starting in 1930. During those dry years, field bindweed became such a serious problem that the Experiment Station began to study ways to get rid of it. Studies made at Columbus and in Paulding, Henry,



Dry seasons favor bindweed

Left—Close-up view of bindweed infested area at Columbus in June 1934 after succession of dry seasons; Right—Same area in July 1939 after three normally wet seasons (considerable weak bindweed present but too small to show)

and Van Wert Counties show that treatment with 3 to 4 pounds of sodium chlorate per square rod from September to November will kill small patches. Lighter applications, and sometimes even these, require retreatment to kill surviving plants.

On heavy soils, treatment should be confined to relatively small areas, because on such soils the material appears to stay in the subsoil in killing concentrations for long periods. For example, an area of Paulding clay on which bindweed was killed in 1935 by 3 to 6 pounds of sodium chlorate per square rod has not produced a profitable crop since. On the same soil, spots of Canada thistle were killed in the fall of 1935, and on these spots alfalfa-grass mixtures were severely injured by the chlorate still in the soil in the late summer of 1938. Since no injury appeared until the dry weather of late summer, it is assumed that the chlorate had been leached to a considerable depth, which was reached by the forage crop roots only after moisture supplies in the upper soil horizons had been exhausted.

WHITE CLOVER IN PASTURES SAVES MONEY

Ohio's permanent pastures seem in general to be able to use more nitrogen than any other single element. The second 100 pounds of 20 per cent nitrogen fertilizer commonly produce as much increase as the first 100 pounds. Since heavy nitrogen applications are expensive, it is important for the farmer to know how much nitrogen he can add by maintaining a high white clover content in his pasture.

The Experiment Station has conducted numerous studies to determine the amount, and finds that where other factors are not limiting, white clover may increase the nitrogen content of herbage removed in a single year by 175 pounds per acre. This amount is equivalent to the nitrogen contained in 875 pounds of sulfate of ammonia, which, at current prices, would cost about $17.50. The content of nitrogen in Kentucky bluegrass grown in a pasture with white clover has often been 50 per cent higher than that in grass grown alone.

WHITE CLOVER STRAINS DIFFER IN VALUE FOR PASTURES

Since white clover is of such vital importance in the permanent pastures of Ohio, farmers are interested in knowing how the different strains compare as pasture plants. Investigations on Station farms at Wooster, Columbus, and Troy and on private farms elsewhere in the State have revealed some comparative values.

Louisiana wild white, a medium-sized strain, has been more drouth resistant than other strains and has been most effective in increasing the yield of bluegrass pastures. It was second choice of grazing livestock and persisted well under grazing.

Ladino, a large type, was first choice of the livestock. It withstood drouth fairly well but gave way rapidly under close grazing. It has been the only strain to hold its own in competition with Kentucky bluegrass for a full year without clipping or grazing.

Kent, or English wild white, a very small, close-growing strain, has withstood close grazing better than any other strain studied but has been least effective in increasing the yield of herbage into which it was introduced. It has also been least resistant to drouth.

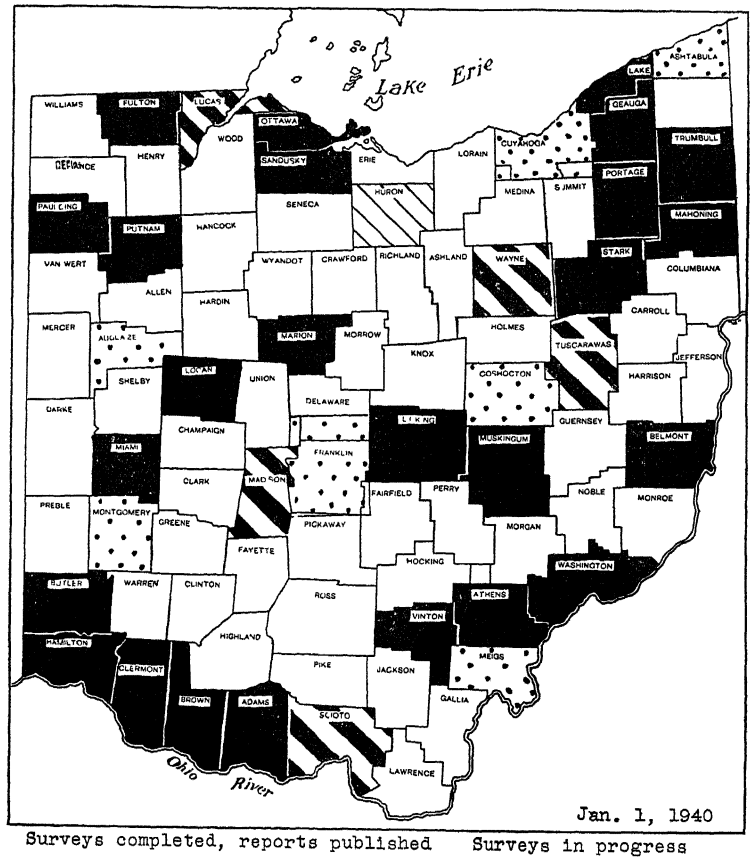
Wisconsin wild white, a strain a little smaller than Louisiana, was second to Kent in its disappearance with drouth.

A strain of Corn Belt origin, corresponding somewhat to that growing wild in Ohio, was more resistant to drouth than Kent and Wisconsin. It was slightly smaller and less vigorous than Louisiana but ranked close to Louisiana in increasing the yield of herbage of bluegrass pasture into which it was introduced.

Ladino and Louisiana were more tolerant than Kent and Corn Belt of shortages of lime and phosphorus.

OHIO SOIL SURVEY PROGRESSES

The map shows the progress of the Soil Survey in Ohio to date. During the field season of 1939, soil survey operations were started in Huron County by the Experiment Station in cooperation with the United States Bureau of



The Ohio soil survey

Plant Industry. The supply of reports and maps for Paulding, Portage, Trumbull, Geauga, and Hamilton Counties has been exhausted. The Soil Survey for Scioto County is now available.

SOIL COLORS STANDARDIZED BY WHIRLING DISK METHOD

Soil surveyors in Ohio find that soil color is the best indicator of natural drainage. Now, instead of merely describing soil colors in words, surveyors are able to analyze any given color into its component parts—white, black, yellow, and red—stating the proportion of each in percentage. They do this by matching the color of the soil with that of a motor-driven whirling cardboard disk carrying white, black, yellow, and red segments whose size can be varied and read as percentage of the whole circle. During the past year, 14 typical colors were chosen as standards for Ohio soils, and these were analyzed by the color-disk method. The color analyses for four of this group, together with the drainage characteristics associated with each, are:

Color	Drainage	Color analysis			
		White	Black	Yellow	Red
		Per cent	*Per cent*	*Per cent*	*Per cent*
Dark gray	Poorly drained	9.8	80.2	5.0	5.0
Gray	Fairly well drained	24.5	54.0	13.0	8.5
Grayish-brown	Well drained	8.5	58.0	17.0	16.5
Reddish-brown	Very well drained	3.5	52.5	17.0	27.0

WALNUT AND LOCUST TREES IMPROVE GRASS GROWTH

Farmers have often observed that grass under certain trees, especially walnut and locust, seems to grow better than grass away from the trees. Actual harvests of grass from beneath such trees have been compared with harvests from areas bordering the trees. The results, averages from a considerable number of sites, show that there was 25 per cent more grass under the trees than outside.

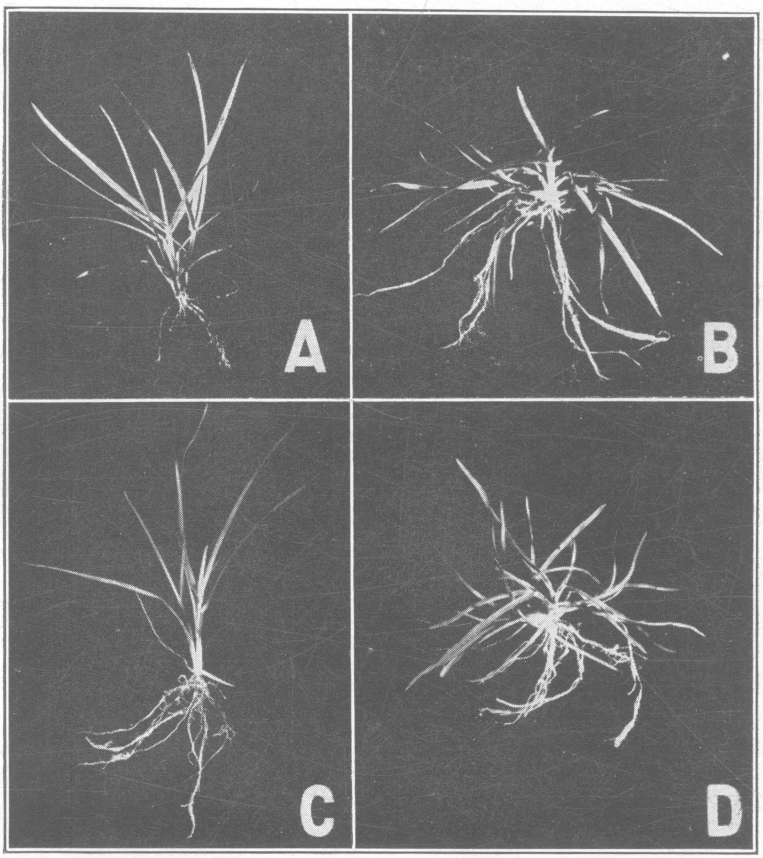
Experiments show this increase to be associated with more organic matter, more soluble mineral nutrients, and more moisture in the soil beneath the trees. Both the date of emergence of the leaves and their speed of decomposition after they fall seem to play an important part in producing the better growth of grass under locusts and walnuts.

DAY LENGTH AFFECTS BLUEGRASS

As an aid to determining proper management practices for pastures and lawns, detailed studies are being made of the growth habits of Kentucky bluegrass under various conditions.[2] Among the influences on growth studied has been length of day. It is a matter of common observation that young plants grow in an upright form during the comparatively long days of late spring and that the leaves bend over and lie on the ground during the shorter days of late fall. That these differences in growth are really the result of differences in day length and not in temperature, was shown by growing bluegrass under conditions where day length could be controlled artificially.

[2]The U. S. Bureau of Plant Industry is cooperating in these studies.

When plants were grown in the fall, but with the period of illumination extended to 18 hours with electric lights, the stems grew in an upright position in much the same way as they do in late spring under natural conditions. Also, when plants were grown in late spring, but with the period of illumination reduced to 8½ hours by covering them with a dark box from 4:30 p. m. to 8:00 a. m., their habit of growth resembled that of plants growing in the fall under natural conditions.



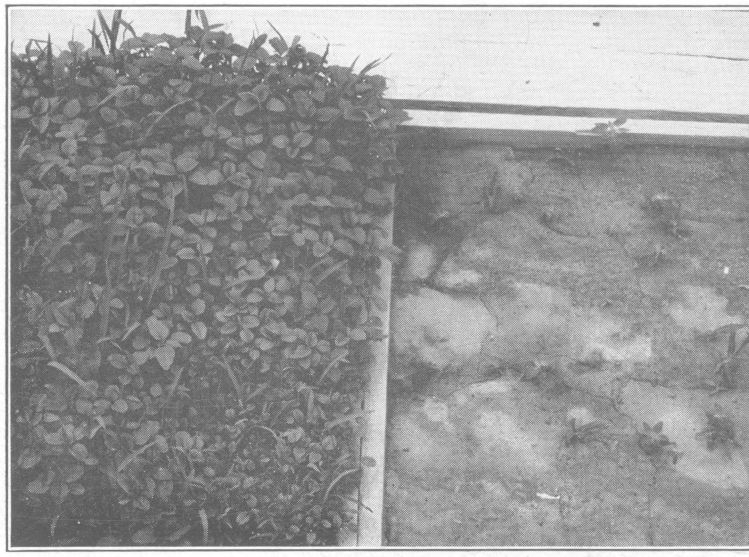
Day length affects growth habit of Kentucky bluegrass

A, growth under natural conditions in the spring; B, growth under natural conditions in the fall; C, growth with 18-hour day in fall; D, growth with 8½-hour day in the spring

TEAR GAS KILLS WEED SEED

Treatment with chloropicrin (tear gas) appears promising as a method of preparing weed-free soil for plant beds, for top-dressing golf greens, and for other purposes where live weed seed is particularly objectionable.

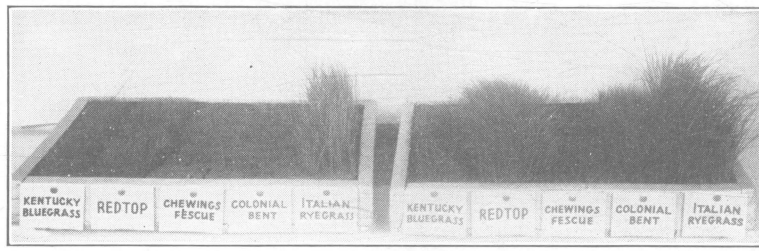
In one experiment, two boxes, about 2 by 3 by 1½ feet, were filled with Wooster silt loam soil in the fall. In both was included a layer of soil which



Soil treated with chloropicrin (right), untreated (left)

contained 30 different kinds of weed seeds. The two boxes stood uncovered in the open all winter. In May, one was treated with chloropicrin at the rate of 15 ounces per cubic yard, covered, and sealed with glue-coated kraft paper. After standing 5 days, the contaminated layer of soil was equally divided, removed to flats partially filled with sterilized soil, and placed in a greenhouse under conditions favorable for germination. Similarly, the contaminated soil from the control box was removed to the greenhouse and placed in flats beside those containing the treated soil. Of the 30 kinds of weed seed mixed in the soil there appeared seedlings of 3 kinds only in the treated flat—lamb's-quarters, goose grass, and crabgrass—and these were few in number.

Chloropicrin did not injure the productivity of the soil. On the contrary, it increased the yield of grass.



Chloropicrin increased the yield of grass.

Five kinds of grass growing on soil previously treated with chloropicrin (right), untreated (left)

PLANTS AND PLANT DISEASES

Research by Experiment Station plant disease specialists has greatly changed the spraying program for the control of fruit diseases during the last several years. This change represents the third step in the development of materials for apple scab control. First Bordeaux was the standard spray, then lime-sulfur, and now the flotation type of mild sulfur is generally recommended. The reason for these changes each time has been injury in one form or another.

The 1939 series of tests was about the same as that of 1938, and the results confirmed the previous tests. In general, however, the season was unfavorable for scab development, and not too much dependence can be given to the evaluation of materials. Slightly better scab control resulted when flotation sulfur was used in the preblossom period than when the more finely ground (micronized) sulfurs were used in that period.

FIXED COPPERS AND BORDEAUX CONTROL CHERRY LEAF SPOT

During 1939, extensive fungicide tests were made on sour cherries. It was hoped that these tests would result in a definite standard schedule for the control of cherry leaf spot. Part of the work was the evaluation of the following fixed coppers: the basic copper chloride types, the basic copper sulfates, brown cupric oxide, Coposil, Bordow, copper naphthenate, and copper oxychloride sulfate. Lime-sulfurs and flotation sulfurs were also used. The season was very favorable for leaf spot, and excellent evaluations of materials were obtained. Most of the fixed copper compounds controlled leaf spot at 3 pounds (based on 25 per cent metallic) per 100 gallons of water and 3 pounds of hydrated lime. A 1-2-100 Bordeaux mixture also controlled well. The sulfur combinations did not control.

Color, quality, and size of cherries were all affected by the different spray materials. Cherries sprayed with fixed copper or 1-2-100 Bordeaux were darker in color and contained about 12 per cent more sugar and acids than the check or sulfur-sprayed fruit. Lime-sulfur again reduced the size of the leaves.

Addition of a spreader, such as Orthex or Tergitol No. 7, increased the fungicidal efficiency of the fixed copper compounds.

The fixed copper formula, 3 pounds of copper (based on 25 per cent metallic) plus 3 pounds of hydrated lime in 100 gallons of water, may also be used as a standard spray for plums and sweet cherries. It might be well to use flotation sulfur in the preharvest spray on sweet cherries for brown rot control.

VEGETABLE DISEASE CONTROL STUDIES ENLARGED

As a result of the increasing seriousness of leaf blights lowering the quality of many vegetables, it has become necessary to enlarge the Station's vegetable disease control work. Since the entire problem of leaf blights is relatively new, a detailed study of the fungicides and their application was necessarily the first step.

Several fixed copper compounds used either as dusts or sprays successfully controlled *Alternaria* and *Septoria* leaf spots of tomatoes in experimental plots.

Applications begun before *Septoria* leaf spot appeared gave significantly better control of the disease than those delayed until the disease was present. In a comparison of southern- and northern-grown tomato plants which were treated in a Georgia field and in cold frames at Wooster, respectively, with Bordeaux mixture and various fixed coppers, the northern-grown plants produced at least 10 per cent more fruit than those from the south. In a similar trial in 1938, the southern plants produced the most fruit. Direct-seeded tomatoes at Wooster developed *Septoria* blight on untreated plants just as severely as did transplants, but the infection began and reached maximum severity about 10 days later on the direct-seeded plants than on the transplants. Some of the spray treatments used on this direct-seeded crop increased the yield over untreated plots as much as 8 tons per acre to a total yield of 19 tons per acre.

Early blight of celery, which occurred in epidemic form in 1939, proved to be difficult to control by weekly applications of Bordeaux mixture. Some of the fixed copper compounds tested on this crop failed to give much control of the disease. Others compared favorably with Bordeaux mixture and copper-lime dust. Dusts gave as good results as sprays in most instances.

Carrot yields were increased by spraying with the fixed coppers only if disease was of at least medium severity on untreated plots. Yields were decreased in most instances, and some compounds caused a considerable decrease.

Dust mixtures containing both a fixed copper and an insecticide again gave better control of bacterial wilt and greater increases in yield on cucumbers and muskmelons than did mixtures containing only an insecticide.

Spraying Lima and snap beans with the fixed coppers for the control of bacterial leaf spots failed to increase yields when disease was not common on untreated plants, and the advisability of using a spray program for beans is still as questionable as before.

As a group, the fixed coppers have been considered less likely to cause injury leading to reductions in yield when used on certain vegetables, such as tomatoes and the cucurbits, than Bordeaux mixture. In general, they are less likely to, but during the past few years plants treated with certain of the fixed coppers have, in the absence of disease, produced less than untreated checks. Bordeaux mixture and several fixed coppers reduced the yield of carrots in two experiments where no disease developed on untreated plants. Bordeaux mixture caused the smallest decrease of all, and Cuprocide 54-Y caused the greatest amount of leaf injury. Coposil reduced the yield of tomatoes in several experiments where disease was not serious. It is not as injurious on this crop as is Bordeaux mixture, however. Several times, Bordeaux mixture and certain of the fixed coppers caused a delay in the ripening of treated tomatoes and muskmelons by preserving the foliage of the plants. In general, anything that tends to increase vegetative growth or preserve the foliage of plants delays the ripening of the fruit. Grasselli Copper Compound-A has caused the most noticeable delay in ripening on muskmelons, Coposil the most on tomatoes.

FUNGICIDE FLOW DEPENDS ON DENSITY

A wide variety of dust mixtures, both of the proprietary and experimental types, is prepared and used each year in an effort to control plant diseases. The density of the constituents of these mixtures may vary from 2 to 16 grams per cubic inch, and most of the usual mixtures prepared from these vary between 4 and 9 grams per cubic inch. Mixtures selected from each end of this density

range may be expected to flow through a particular setting of the feed slot of a duster at quite different rates; as a result, offhand adjustments of a duster to afford the application of a definite amount of dust per acre are almost impossible. Dust mixtures in which any constituent is definitely sticky or abrasive may flow much slower or faster than others of similar densities, but these special cases need not be considered in standardizing density and flowability of dust mixtures. Such a standardization would be highly desirable in comparing a number of dusts in experimental tests or in dusting large areas for the control of disease.

Tests with many of the fungicidal and filler materials commonly combined as dust mixtures have indicated that a density between 6.5 and 7.0 grams per cubic inch is desirable. This density may usually be reached by the proper combination of two filler materials of different densities to effect variations in the density of the fungicidal or insecticidal constituents used.

COPPER DEPOSITS FROM FUNGICIDES VARY

When one compound, such as tribasic copper sulfate, was mixed with various fillers in the preparation of fungicidal dust mixtures, the percentage of copper found in deposits collected on glass slides placed at particular distances from the nozzle of the duster varied widely, as did the total weight of the deposit.

The percentage of copper present in the deposit when a dust containing 6 per cent of copper was blown from a small power duster and collected at a distance of 10 feet varied from 3.02 per cent when bentonite was the filler to 8.14 per cent with a filler of collector fines whiting. At 20 feet the respective percentages were 5.40 and 12.57. The total amount of copper present per square inch of slide area was not very great at either distance although the total weight of the deposit was nearly three times as great with the bentonite as with the whiting. The greatest amount of copper was collected from a medium density talc and the least from hydrated dusting lime. The heaviest deposit occurred with rather coarse whiting and the least from collector fines whiting in a group of 10 fillers.

When 15 different insoluble coppers were mixed with flour and talc as fillers, the greatest amount of copper recovered at a distance of 10 feet from the duster nozzle was with Cupro-K, the least, with Coposil. At 20 feet, tribasic copper sulfate showed the largest amount of copper per unit of slide area and Coposil the least.

These various relations are of particular interest with reference to the drift type of dusting in which the dust is blown from a duster at a high velocity so that it may settle on plants over a considerable distance from the nozzle.

NEW DEVICE TELLS WHEN IRRIGATION IS NEEDED

The Experiment Station has developed a new instrument that shows growers when to water lawns, vegetable gardens, potato fields, and other areas that need supplemental irrigation and how much water to use. This device helps growers to maintain soil moisture at the right level for good plant growth without wasting water.

The instrument consists of a combination evaporimeter and rain-catching funnel which makes it possible to determine when evaporation has exceeded rainfall enough to make watering necessary.

LEAF BLIGHT OF SUGAR BEETS UNDER CONTROL

During the past few years, *Cercospora* leaf blight of sugar beets has become serious enough to limit sugar beet growing in northwestern Ohio. To combat this new threat to an Ohio crop, Station plant pathologists started a small series of control tests in 1938 and conducted a very extensive series in 1939. In these tests, Bordeaux and fixed copper sprays and copper-lime and fixed copper dusts were used as control measures. Timing and methods of application, and diluents were studied, and the following conclusions were reached:

The control measures increased tonnage 20 to 50 per cent, sugar content about 1½ per cent, and purity 2 to 6 per cent.

Dusts gave less control than sprays but greater yields.

Fixed coppers may be applied in the daytime as well as when the foliage is wet.

Copper-lime-flour dust was slightly superior to other dusts.

Talc was the best diluent, and flour added sticking qualities.

Three to four applications were adequate, the first about July 10 to 20, the rest following at 10-day to 2-week intervals.

NEW TOMATO LEAF MOLD BREAKS OUT IN OHIO

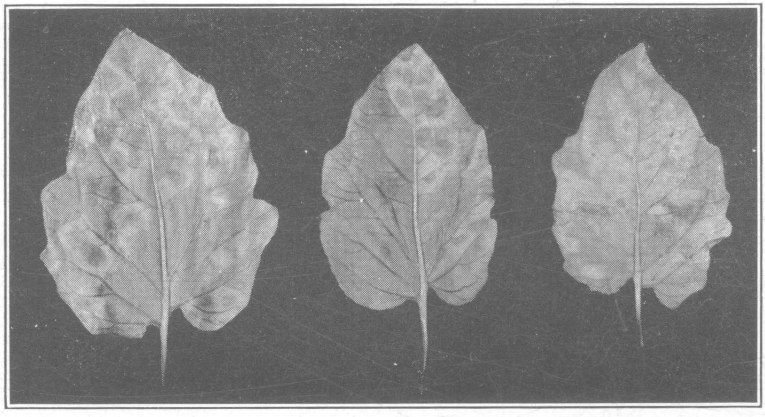
In 1937 the new tomato variety, Globelle, resistant to leaf mold disease was released. This variety had as its resistant parent, the wild tomato species *Lycopersicon pimpinellifolium*, which had been shown to be highly resistant in two locations in the United States and in Canada, England, Germany, and Australia. Near the end of the 1937 cropping season, leaf mold lesions appeared on some of the selections from which seed for the variety Globelle had been composited. Since that time leaf mold has occurred on Globelle throughout northern Ohio. The disease does not seem as severe on Globelle as on Globe, however.

Seeking an explanation for this sudden loss of resistance, pathologists conducted cross-inoculation experiments using spores of the fungus collected from diseased leaves of the resistant variety Globelle and spores from diseased leaves of the susceptible variety Globe. The spore collections were made at widely different locations in the State. In the following table is a summary of results of three such experiments.

Cross-inoculation experiment with Globe and Globelle strains of the fungus

Variety	Plants inoculated with Globe strain		Plants inoculated with Globelle strain	
	Healthy plants	Diseased plants	Healthy plants	Diseased plants
Globe	0	20	0	19
Bonny Best	0	8	0	8
Potentate	0	20	0	20
Sterling Castle	0	20	0	19
L. pimpinellifolium	20	0	0	20
Globelle	20	0	0	20
Veto Mold	31	0	0	12
Bay State	16	0	0	13

Note that the four commercial varieties are susceptible to both strains of the fungus, whereas the wild species, *L. pimpinellifolium*, and the three resistant varieties developed from it are resistant to the Globe strain and susceptible to the Globelle strain.



Leaflets of the wild tomato species *L. pimpinellifolium* naturally infested with the new strain of the fungus

The origin of the Globelle strain of the fungus is uncertain. It was first observed in a greenhouse near Vermilion, Ohio, and seemed to spread from there. Previous to its appearance in this greenhouse, the variety Globelle had proved completely resistant when grown in widely separated areas in Ohio. Furthermore, since the introduction of Globelle, several investigators in other states have found it completely resistant. This information plus the fact that investigators in other countries had found *L. pimpinellifolium* highly resistant tends to indicate that the new strain of the fungus, named *Cladosporium fulvum*, is of recent origin.

At the present time a search is being made to secure resistance to the new form of the fungus. In this work a collection of about 500 wild and cultivated species from South and Central America is being sorted over.

WILT OF CHRYSANTHEMUMS CAN BE CONTROLLED

Four hundred and twenty-three varieties of florists' chrysanthemums have been tested at the Experiment Station for resistance to *Verticillium* wilt. Those which failed to develop symptoms and from which the fungus could not be isolated from stems grown in soil heavily infested with *Verticillium* are considered resistant. Roughly one-third of the varieties tested fall in the resistant group.

Attempts to eliminate the fungus from cuttings by allowing them to take up fungicidal solutions before being placed in sand to root have resulted in failures thus far.

Further experiments on control corroborated the work of last year, which indicated that the disease can be controlled by selecting healthy, vigorous plants in the fall before the flowers are cut to carry over as stock for next season's crop. Rooted cuttings from such plants produce a high percentage of healthy plants when grown in sterilized or *Verticillium*-free soil.

Healthy plants of the Mary Lenon Hall variety grown in *Verticillium*-free soil yielded at the rate of 4.6 ounces per plant, had an average of 6.2 flowering stems per plant, and attained an average height of 34 inches. Healthy plants of this same variety set in soil infested with *Verticillium* became diseased and yielded 0.92 ounce per plant, had three flowering stems per plant, and averaged 20 inches in height. Plants affected with *Verticillium* and grown in soil free of *Verticillium* at the start yielded 0.47 ounce per plant, had an average of 1.16 flowering stems per plant, and averaged 18 inches in height.

WETTABLE SULFUR CONTROLS RUST ON ASTERS

Wettable sulfur used at the rate of 1 ounce to a gallon with a spreading agent gave good control of rust caused by *Coleosporium solidaginis* on asters grown in a cloth house. Six applications were made at 1-week intervals, starting July 5. Flowers were cut from sprayed and unsprayed plots and records taken on rust control. If a single rust lesion appeared anywhere on the leaves, stem, or flower bracts, the blossom was counted as rusted. A large percentage, 88.9, of the flowers from the unsprayed plot showed rust, but only 20.2 per cent from the sprayed plot were rusted. Most of the flowers counted as rusted in the sprayed plot had very few rust lesions and were usable.

INSOLUBLE COPPERS RECOMMENDED FOR *SEPTORIA* LEAF BLIGHT OF POMPONS

Some of the insoluble coppers, an organic copper, and an organic sulfur were used as fungicidal sprays on two varieties of pompons, Minong and Sea Gull, grown in a cloth house in an experiment on the control of leaf blight caused by *Septoria*. A spreading agent was used with all sprays. The first application was made July 3, and subsequent treatments were made at weekly intervals until six sprays had been applied.

Very little leaf blight developed in any of the Minong plots. Considerable blight did occur in the Sea Gull check plot. The leaves of plants in this plot were killed for a distance of one-third to one-half of the stem length, and numerous blighted spots also occurred on the higher leaves. Very little blight developed in any of the plots which received fungicidal sprays. The yield from 48 plants in the Sea Gull check plot was twenty-four 9-ounce bunches, whereas the average yield from all sprayed plots of a similar size was thirty-two 9-ounce bunches.

The results of this experiment indicate that *Septoria* leaf blight of chrysanthemums is fairly easy to control by fungicidal sprays.

Because they are readily available, easy to mix, and effective, the insoluble coppers used at the rate of one-half ounce per gallon (based on material with 25 per cent metallic copper) with a spreading agent are advised for controlling this disease.

HOT WATER DOES NOT ELIMINATE PEONY ROOT KNOT

In the fall of 1931, peony roots of a number of varieties, all infected with the root knot nematode, *Heterodera marioni*, were obtained from different nurseries in the State. Representative lots of these roots received the following hot water treatments: 118° F. for 45 minutes, 120° F. for 30 minutes, and 122°

F. for 30 minutes. After treatment, the roots were planted in a fairly heavy, fertile soil. An untreated lot of roots was planted approximately 50 feet from the treated ones to serve as a control. These peonies have been growing in the same location ever since. Both treated and untreated lots have been growing well and have flowered each season. The treated lots, except for a very few plants, have grown no better than the untreated ones.

In the fall of 1939, part of these roots were taken up and examined for nematode galls. Twenty-seven check plants and nineteen treated ones were examined in all. Numerous galls were found on all the check plants, whereas only 10 of the 19 treated plants had galls on the roots. None of the three treatments eliminated nematodes from all the plants treated at that particular temperature.

The evidence indicates that hot water treatments will reduce nematodes in peony roots but will not completely eliminate them from all roots. Since this is true and since most nematode-infected plants grow and flower well in heavy, fertile soils, it is doubtful whether hot water treatments are worth while as a control measure for peony root knot.

DISEASE-RESISTING CORN HYBRIDS DEVELOPED

The program for the production of disease-resisting corn hybrids adapted to Ohio growing conditions was enlarged during the past season.[3] Several diseases received particular attention. Among these were leaf blight caused by *Phytomonas stewarti* and *Helminthosporium* spp.; stalk rot caused by *Diplodia zeae, Gibberella saubinetii,* and certain other soil-inhabiting fungi; and the common corn smut caused by *Ustilago zeae.*

During the past year the program included detailed observations and study of old and promising new hybrids in cooperative plantings and experimental fields in representative areas of the State; extensive testing of both new and old inbreds and hybrids by means of artificial inoculation with the disease-producing organisms; a study of the interrelation of climate, soil, and disease; and a classification of new and old inbreds and hybrids on the basis of their reaction to the different diseases.

Several promising new inbred lines have been obtained which possess a high degree of resistance to the leaf blight disease, and a few have been found which possess considerable resistance to stalk rot and smut. A few inbreds were found in which the factors for resistance to two or even all three diseases were combined. It appears likely that within a few years many of the hybrids now grown in Ohio will be replaced by new hybrids which will be decidedly more resistant to disease as well as superior in other ways.

Several such hybrids containing two or more of these new disease-resisting inbreds will be released in experimental plantings in 1940.

BACTERIOPHAGE SIGN OF WILT RESISTANCE IN CORN

Investigations of the bacterial wilt disease of field and sweet corn have indicated that the bacteriophage, which is commonly found in diseased plants, originates as a result of the antagonistic action of the corn plant against the bacteria which cause the wilt. This discovery has led to a detailed examination of the juice or extract of corn plants for the purpose of gaining further information regarding the reaction between host and parasite.

[3]The Botany and Agronomy Departments of the Ohio Agricultural Experiment Station, and the Bureau of Plant Industry of the U. S. Department of Agriculture are cooperating in this program.

It has been learned from these investigations that corn hybrids or strains which exhibit resistance to bacterial wilt have strong lysins, whereas those which are susceptible to the wilt possess very weak lysins or none at all. It was also discovered that other members of the grass family, to which corn belongs, such as wheat, oats, rye, cheat, and Kentucky bluegrass, as well as unrelated species of plants, such as apple, celery, crimson clover, tomato, cabbage, peach, and many others, have lytic substances present in their saps effective against the corn wilt organism. None of these plants are recognized to be attacked by that organism.

A critical study of the lysin found in wheat leaves revealed that it is not the same as the transmissible lytic substance which is recognized as the bacteriophage. The former is inactivated by heating at 56° C. for 30 minutes, but the latter can withstand 65° C. for the same period. When the corn wilt bacteria are brought into contact with the lytic substance of plants, a bacteriophage is developed for that organism.

If the antagonistic action of the corn plant against invading bacteria results in the formation of a transmissible lytic substance, known as the bacteriophage, it would be logical to think of the phage as an expression of resistance on the part of the plant. Corn varieties which are resistant to the wilt should, therefore, give rise to the phage, and those which are susceptible should not. This theory was verified by an examination of nine different varieties of sweet corn, five of which are known to be resistant to the bacterial wilt disease, four susceptible. Only in the resistant varieties could a transmissible lytic factor be developed against the bacteria which cause the wilt diseases.

GREENHOUSE TOMATOES THRIVE IN NUTRIENT SOLUTIONS

Largely because of the intensive cropping, soil-borne diseases often become a serious problem in greenhouses. Sterilization of the soil by steam controls such diseases effectively, but steam sterilization has several disadvantages. Attempts have been made, therefore, to grow plants in nutrient solutions, to eliminate the soil and with it, the necessity for sterilization.

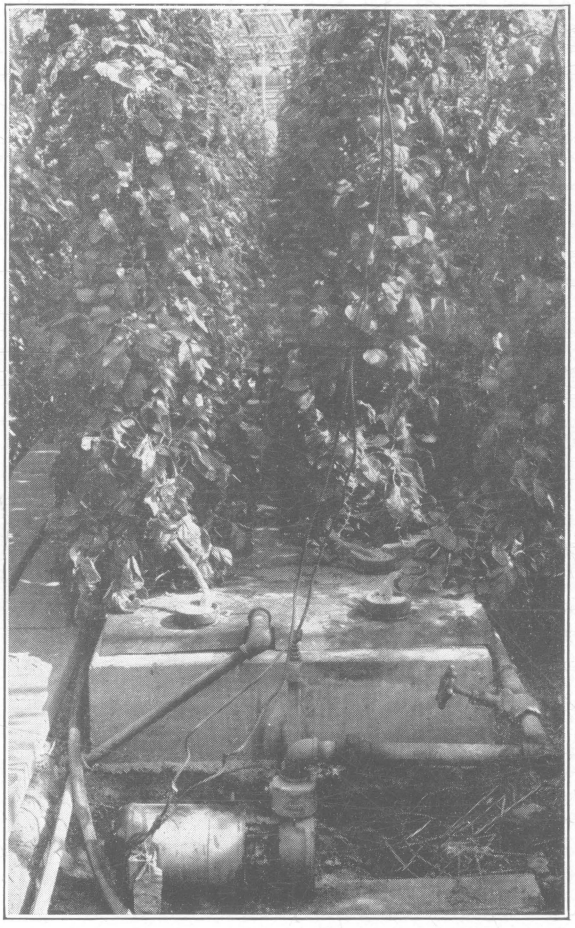
Three methods of culture have been used—drip, subirrigation, and solution. Good tomatoes were grown by the drip method, but it is too expensive from the standpoint of labor to be practical. Some medium, such as gravel, Haydite, or cinders, is necessary in the subirrigation method, and since a medium soon becomes filled with organic matter, some form of sterilization is required when it is used for successive crops. It is also more difficult to maintain large benches of solid medium at the proper temperature for the greatest root activity of some vegetables than it is to heat solutions to the proper temperature. For these reasons, most of the Experiment Station's work has been with the solution method, using no solid medium.

Experiments have indicated that tomatoes need about 1 cubic foot (7½ gallons) of solution per plant and that this solution should be aerated for a short time at least once in every 4 hours. The cost of circulating the solution so that it can be aerated and maintaining it at the correct temperature is not excessive.

Experimental units using the solution culture method are in operation at Wooster and at the Ruetenik greenhouse at Vermilion. For the past four cropping seasons very good yields of tomatoes have been obtained. The highest

yield in a fall crop has been 8.7 pounds per plant and the highest yield in the spring, 14.5 pounds per plant. The lowest yields were 5.04 and 10.94 pounds per plant, respectively, in the fall and spring crops.

In commercial tomato houses in ordinary soil culture, the yield of fall tomatoes is below 6 pounds per plant, and 10 to 11 pounds is an average yield in the spring. The highest known yield in a commercial spring crop is slightly under 14 pounds. Plants produced in solution culture have outyielded soil-grown plants in both spring and fall crops.



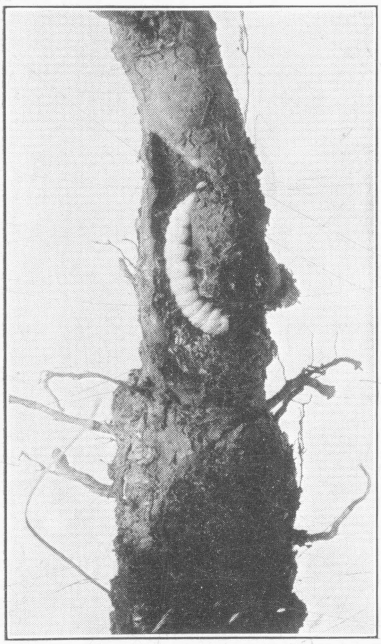
Greenhouse tomatoes growing in nutrient solution

It is too early to answer all questions involved in growing tomatoes by the solution culture method, but the indications are that the yields from good nutrient solution culture will exceed those of good soil culture.

INSECTS AND THEIR CONTROL

NEW MATERIALS CONTROL PEACH TREE BORER SAFELY

For years, Ohio orchardmen have been using paradichlorobenzene crystals to control the peach tree borer, *Conopia exitosa* (Say). However, as a result of work done chiefly in the South, this material is considered unsafe for use on trees less than 3 years old. Fortunately, recent investigations have produced two substitute materials—ethylene dichloride emulsion, and paradichlorobenzene in cottonseed oil emulsion. All three materials were compared in Ohio during 1938 and 1939.



Mature larva of peach tree borer and damage to young peach tree

Although paradichlorobenzene in cottonseed oil emulsion was as effective as paradichlorobenzene crystals alone, it cannot be recommended. It is more troublesome to apply and is considerably more expensive.

Ethylene dichloride emulsion was tried at the Experiment Station during the fall of 1939. A 15 per cent emulsion was applied to 2- and 3-year-old trees; 15 and 25 per cent strengths were used on trees 7 years of age. At no strength did the emulsion cause discernible injury, and excellent control of the borer was obtained. No living borers were found on any of the 62 trees treated although 40 of the trees showed evidence of borer injury. Only six dead borers were found. Many larvae may have disintegrated before the examinations were completed, however, because 6 weeks had elapsed between the time of application of the treatment and the last examination.

Experiments with nursery stock in Lake County and at the Experiment Station involved over 4,000 trees. It was found that most of the borer injury to these trees occurred during the summer following the budding operation. Results of the work of the season indicated that both ethylene dichloride emulsion and paradichlorobenzene in cottonseed oil emulsion were safe in summer applications at strengths that would kill the borers. Further work on this project must be done to determine the best time or times to apply the materials, and the proper emulsion concentration.

NEW SPRAYS FOR APPLE APHIDS TESTED

Aphid injury to apple is an almost annual problem in some sections of Ohio. Two species, the rosy apple aphid, *Aphis rosea* Baker, and the green apple aphid, *A. pomi* DeGeer, do most of the damage. Three other aphid species appear on apple in Ohio but are seldom injurious enough to need commercial control. These are the woolly apple aphid, *Eriosoma lanigera* (Hausman), the apple-grain aphid, *Rhopalosiphum prunifoliae* (Fitch), and the clover aphid, *A. bakeri* Cowen.

Of the two injurious species, the rosy apple aphid usually causes more damage. Because of its habit of curling the foliage, it cannot be attacked successfully after hatching. Sprays must be used against the eggs. During the past 5 years, several new egg-killing sprays have been tested and evaluated by the Ohio Station.

Tar-oil emulsions or washes.—These materials give excellent control of aphid eggs. Two and one-half per cent of tar-oil should be used, and if spraying is thorough, 100 per cent control should result. Tar-oil is effective against different scales but not against European red mite. It must be used while the trees are dormant. Tar-oils are expensive. Spray men using them must protect their face and hands.

Tar-oil plus petroleum oil.—This combination may be used where European red mite must be controlled. It is effective also against aphids and scale. The same precautions in its use must be observed as for tar-oil. Its cost is greater because of the addition of the petroleum oil.

Dinitro oils.—These materials consist of a petroleum oil plus a small amount of dinitro-o-cyclohexyl phenol, which is the egg-killing agent. They are very effective against aphid eggs, scale, and red mite but are rather expensive, must be used in the dormant period, and may injure the skin of the operator.

Elgetol.—This is a commercial product somewhat related to Dinitro. It is very effective against aphid eggs and bud moth and is also effective against scale, though the kills obtained are usually not quite as high as with petroleum oils. It is expensive, must be used in the dormant period, and must be kept off the face and hands of the operator.

The evaluations of these spray materials for aphids have been secured by laboratory and field tests conducted with a new and original technique which has expedited the collection of data and assured the results.

New developments in technique have also been used in experiments against the green apple aphid, *A. pomi.* Owing to its migratory habit, this species cannot be controlled in the egg stage. The living insects must be attacked when present on the trees. The tests against *A. pomi* included many new combinations and types of rotenone and pyrethrum, but showed that nicotine sulfate is still the most reliable control agent. The following formula is recommended: nicotine sulfate, ¾ pint; summer oil, ½ gallon; water, 100 gallons.

DEVELOPING POTATO RESISTANT TO LEAFHOPPER

The Experiment Station has made some progress in its effort to find stocks of potato resistant or tolerant enough to the potato leafhopper, *Empoasca fabae* Harris, to permit profitable production without other means of control.[4]

[4]This project is carried on in cooperation with the Bureau of Plant Industry of the U. S. Department of Agriculture.

The common commercial varieties were found to differ significantly in leafhopper populations. Bliss Triumph and Irish Cobbler were definitely susceptible to attack by the leafhopper, whereas Katahdin and Sequoia showed a fair degree of resistance. Early maturing varieties were more heavily populated than late maturing types. The new Sequoia variety exhibited marked resistance to late blight in addition to moderate resistance and tolerance to leafhopper attack, and the combined resistance to these two major hazards contributes to the high yielding ability of this variety. In a single year's test it yielded 31 per cent more tubers than any other commercial variety.

This past season, over 1,500 hybrid seedlings were grown in 8-hill single-row plots. These seedlings represented the offsprings of more than 45 crosses between various sorts. Their leafhopper populations, tolerance, and maturity were noted. Approximately 140 of the seedlings which showed resistance to leafhopper attack or ability to tolerate a population without suffering appreciable hopperburn injury were selected for further study in 1940. Of the 106 selections made from the 1938 plantings, all but 18 were eliminated this past season. Several of those kept have commercial possibilities; others are of value only as possible breeding stocks. The studies indicate varying degrees of resistance among progenies from different crosses.

No one of the commercial potato varieties or of the hybrids from them shows anything like complete immunity from leafhopper. Certain wild species, however, have been found to be immune to attack. Since wild species are of no value for commercial tuber production, an effort is being made to cross those exhibiting immunity with commercially important varieties in an attempt to produce a commercially valuable potato that will be resistant to leafhopper. At present it looks as if immunity can be obtained only through species hybridization.

WIREWORM INVESTIGATIONS CONTINUED

During the year, 2,115 elaterid beetles were collected, and over 30 species were identified among them. Classification is still in progress and will require further study and verification before a list can be presented.

Collections were made in the following 13 counties in the State: Columbiana, Hamilton, Hardin, Lake, Lawrence, Lucas, Mahoning, Pike, Portage, Scioto, Stark, Washington, and Wayne. In eight of these, elaterids were taken in light traps; in five, under traps consisting of inverted pieces of sod in cultivated fields; in two, under codling moth bands in apple orchards. In five counties, they were collected other ways.

The largest numbers of elaterids were taken from codling moth bands, but the number of species found there was very limited. Species taken under codling moth bands were seldom collected elsewhere. Light traps attracted large numbers of the smaller beetles as well as some of the larger ones. A larger number of different species was taken by light traps than by other methods. In some instances the same species were taken under traps in cultivated fields as in light traps, but for the most part, catches in the sod traps consisted of *Agriotes mancus* Say and other *Agriotes* species which do not fly. All these sod traps were located in the northeastern one-fourth of the State.

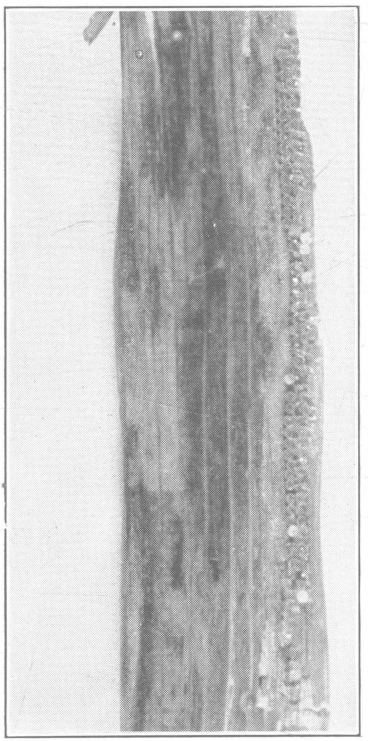
INSECT CONTROL TREATMENTS INCREASE SQUASH YIELDS

In Ohio, squash is subject to attack by several insects. Of these, the striped cucumber beetle, *Diabrotica vittata* (Fab.), the common squash bug, *Anasa tristis* De G., and the squash vine borer, *Melittia satyriniformis* Hubn., are the most injurious. As a rule, the striped cucumber beetle and the common squash bug do the most serious damage, but when the squash vine borer establishes itself in an area it may prevent squashgrowing.

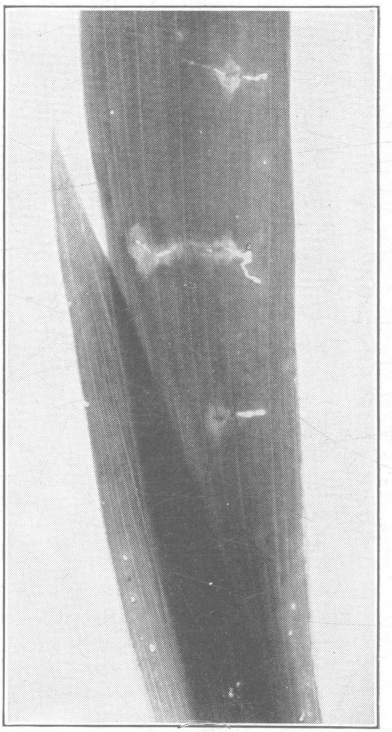
In 1939, Station entomologists used timbo powder, activated pyrethrum, insoluble copper, and lead arsenate in an effort to control the insects attacking summer straightneck squash. Certain of these treatments increased the number of fruits and the weight of the crop over those produced on untreated plots by approximately one-third. The differences in yield between the plots which received the various treatments were not very large, and until they are tested further, any one treatment cannot be recommended over another.

IRIS BORER KILLED BY INSECTICIDE

In recent years, the iris borer, *Macronoctua onusta* Grote, has caused severe injury to iris plantings in different parts of the State. The iris borer deposits its eggs during the fall, usually within the crevices formed by the folding and



Mass of iris borer eggs along margin of leaf that had the edge folded over



Injury to iris leaf by young larvae of iris borer

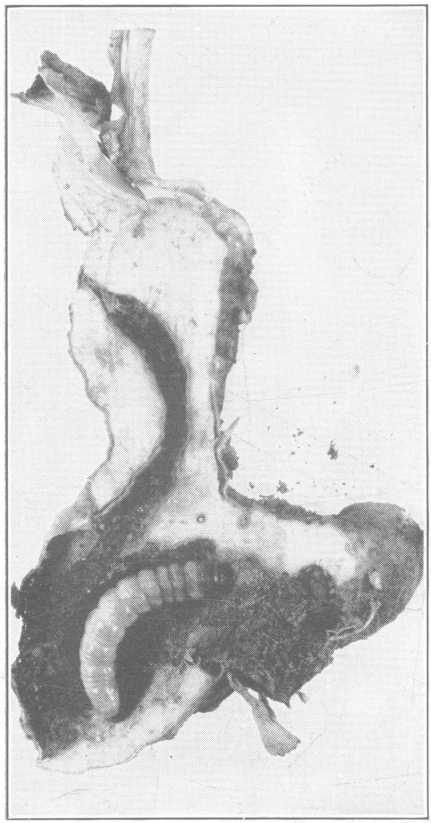
crinkling of dead leaves, and the insect spends the winter in the egg stage. Because of this known behavior, control measures in the past consisted mainly of a thorough cleanup of the iris garden in the fall or early spring to destroy the overwintering eggs. Only moderate control resulted.

Observations on the behavior of the insect made during the past 3 years have shown that the eggs hatched between April 15 and May 5. The young larvae in feeding produce holes in the leaves and small channels within the leaf tissue. For about 2 weeks after hatching, the larvae crawl over the plants and feed for part of the time in an exposed position. As the iris plant grows, the larvae burrow within the fans, back of leaf sheaths, and into the flower stalks and buds. Later they move downward into the rhizomes.

Pupation begins about the tenth of August and continues through the first few days in September. Some of the larvae pupate within their burrows in the rhizome, but most transform in the soil around the iris clump. Adult emergence extends from early September to about the tenth of October.

The entomologists believe that the life history of the iris borer is such that the insect should be killed by insecticides applied to the plant during the first 2 or 3 weeks after the larvae start feeding. A series of sprays and dusts was applied to replicated plots at 5-day intervals during this period in 2 successive years. In 1938, a year in which hatching started on April 15, the insecticides were applied during the last half of April. In 1939, when hatching began on May 2, the treatments were made during the first half of May. Borer population counts on the two series of plots made in August of their respective years showed that a dust containing 1 part Dutox and 4 parts flour killed 87 per cent of the larvae in 1938 and 67 per cent in 1939. In both years this material was far superior to all other combinations used.

Iris fan severely injured by iris borer. Larvae are back of leaf sheaths and within stalk.



Injury to rhizome by full-grown larva of iris borer

TOMATO FRUIT WORM STUDIED INTENSIVELY IN 1939

During the year, Station entomologists divided their work on the tomato fruit worm, now *Heliothis armigera* (Hbn.), formerly *H. obsoleta* Fabr., into three main divisions: field control studies, laboratory insecticide studies, and trap light studies. All three contributed to a knowledge of the habits of the insect and to possible control measures.

FIELD CONTROL STUDIES

Twenty-five combinations with 12 kinds of insecticides were replicated 6 times on plots of 15 Stockdale tomato plants; the plots were randomized in an almost square block. Both sprays and dusts were applied on June 23 and again June 30.

Surveys of the results were made at intervals without picking. The first was made about the time of the initial infestation, and records of the first surveys were kept as a check on final records.

Circumstances caused the first application of insecticides to be put on the plants about 10 days late. Survey records showed approximately 2½ per cent of the total infestation present June 12, 5 per cent June 16, and 20 per cent June 20. For next season, it is planned to apply the first spray about the time the first fruit set is complete on the plants. Any observations on the sparse initial moth population are, of course, apt to be inaccurate.

The degree of control obtained with insecticides was not highly satisfactory. After the tomatoes that were infested June 20 or before were eliminated from consideration, it was found that 12 of the insecticide treatments were significantly better than no treatment at all. All but one of the calcium arsenate spray plots (6 pounds to 100 gallons of water) were among the least infested; there was about one infested tomato in these plots to four in the unsprayed. Living larvae were found in the spray plots a week after the last spray had been applied. Approximately 25 per cent of the fruit was damaged by the spray. Zinc arsenite and alorco cryolite sprays gave about the same degree of control and caused insecticide injury on about 5 per cent of the fruit. Phenothiazine dust plots had half as many infested fruits as the check plots, and no

spray burn. Undiluted calcium arsenate dust gave the same ratio of control with 5 per cent of injured fruit. Paris green spray and dust injured 40 to 60 per cent of the crop, respectively, and gave no greater degree of control than calcium arsenate, zinc arsenite, and cryolite.

LABORATORY TESTS ON INSECTICIDES

Ten dusts were tested in laboratory experiments which involved the use of 800 larvae, each caged separately on a green tomato. Greater numbers of larvae will be needed to arrive at conclusive results.

Apparently there was increasing resistance to the insecticides from instar to instar. No diluted or undiluted insecticide gave a 100 per cent kill in all instars. Some larvae which had suffered no ill effects after their initial entry in one instar died in a later instar when they renewed feeding on the poisoned surface as they attempted to re-enter the fruit. Others penetrated the poisoned surface and then remained in the tomato until they escaped to the soil to pupate and become adults. Some larvae refused to feed on either dusted or undusted fruit and usually escaped. The death of some seemed to result from the effects of the insecticides although they did not feed on the tomato.

TRAPLIGHT STUDIES

Traplight studies were made with 100 W, 250 W, 400 W, and 1000 W type-H mercury vapor lamps; a 100 W type-S mercury vapor lamp; 100 W and 1000 W Mazda lamps; and a battery of five 20 W blue fluorescent lamps.

The vertical-baffle type trap was abandoned for one with a baffle extending halfway around the trap and lamp which directed the rays in only one direction.

When the lights were not in competition, *H. armigera* did not show any preferences except that the 100 W Mazda was not as attractive as the others. The 1000 W mercury vapor lamp did not repel the moths.

Studies made in two cornfields and a tomato patch indicated that no control was obtained even though 124 moths were captured during one experiment. The corn next to the traps was more heavily infested than that in other parts of the field.

EGG-LAYING CORN BORERS PICK ON TALL CORN

One reason why European corn borer population is less in late planted corn is that late corn is shorter at the time the moths are in flight. Corn borer moths always deposit their eggs on the taller corn. A question that frequently arises in connection with recommendations of planting date adjustment is: What would be the behavior of the moths if all corn were relatively short?

Because economic losses occurred in certain areas of Hancock County in 1937, farmers on the best cornland there were advised to adjust their planting dates in 1938 in accordance with the relative productivity of their soil. As a result, the average height of corn at the peak of moth flight was about 2 feet less than in 1937 at this same period. In this area, for the first time, corn borer eggs were found on oats and other farm crops. Evidence pointed to the conclusion that when all corn is short, it will escape egg deposition just as short corn does when some corn in the area is relatively tall.

If this conclusion is correct, farmers should take advantage of differences in the rate of growth of various strains, particularly during the early part of

the season. A strain that grows slowly up to the peak of moth flight should receive fewer eggs than a strain which grows rapidly and is, therefore, relatively tall at moth flight.

In a single-cross experiment in 1939 at Van Wert, Ohio, in which 100 strains were under observation, the number of egg masses per plant was determined for the five tallest and the five shortest strains. There were nearly twice as many eggs on the taller as on the shorter ones. Height measurements taken again at maturity showed that some single crosses grew more slowly than others during the early part of the season but more rapidly in the later part. The same behavior was noted in strains included in the cooperative performance test plots at Van Wert. For example, the double cross (51 × 56) (67 × Hy) was one of the slow-growing strains at the peak of moth flight. It measured only 39 inches at moth flight, whereas the double cross (65 × Hy) (40A × 40B) had reached the height of 45 inches by that time. At the end of the growing season, however, the (51 × 56) (67 × Hy) was the taller. As expected, the strain which was the taller at moth flight also had nearly twice as many eggs deposited upon it as the shorter strain.

On the contrary, in another and similar test, a strain, (WF9 × 40B) (51 × Hy), that gives evidence of borer resistance to larval survival has been found to be one that makes a rapid growth early in the season as compared with (51 × 56) (67 × Hy). As a result, it is more attractive to moths and receives more eggs. The gain of lower survival of larvae because of resistance is, therefore, offset by a higher egg population. A strain that has a combination of escapement, resistance, and tolerance, as well as other desirable characteristics, would be ideal for areas where corn borers are a problem.

LAND USE MAPS HELP LOCATE CORN BORERS

Land use maps made on the basis of soil type, drainage, and proper farm management provide a new and fairly accurate means of locating the areas of the State most favorable to the corn borer. For example, in Van Wert County, where such a map has been made, the levels of soil productivity are indicated as excellent, good, medium, and fair. A study of the corn borer in 111 fields in this area in 1939 showed a stalk infestation of 83, 67, 37, and 19 per cent, respectively, in the four levels of soil productivity. Losses were negligible in the areas rated as medium and fair. On the excellent soil some heavy losses occurred. Knowledge of exactly where economic losses can be expected is a distinct step toward more effective control.

MODIFIED TWO-QUEEN SYSTEM AGAIN SUPERIOR

The Station's modified two-queen system of bee management utilizes two queens in one hive during the building-up period and reduces these two-queen colonies to a single-queen system at the beginning of the major clover honey flow. The practicability of this system has been tested for the second season.

Normal colonies were selected for these tests. On May 11 and 12, about half of the more mature brood with the adhering bees of each colony was placed in a hive body and separated from the lower unit by means of a double screened inner cover that allowed a top entrance for the upper unit. At this time, a young laying queen purchased from the South was introduced to each of the upper units.

On July 1 and 2, the two-queen colonies were reduced to the one-queen system. At this time, most of the young queens were placed in the lower units; the brood nests were arranged to prevent swarming; and the supers were arranged so that maximum storage was encouraged. The check colonies as well as those used in the experiment averaged from 8 to 11 frames of brood on May 12. On July 2, the check colonies averaged practically 11 frames of brood. The two-queen colonies had from 14 to 18 frames on the same date.

The character of the clover flow in 1939 was not conducive to best results in the modified two-queen system. On July 9, when the colonies were at the peak of strength, the honey flow practically ended.

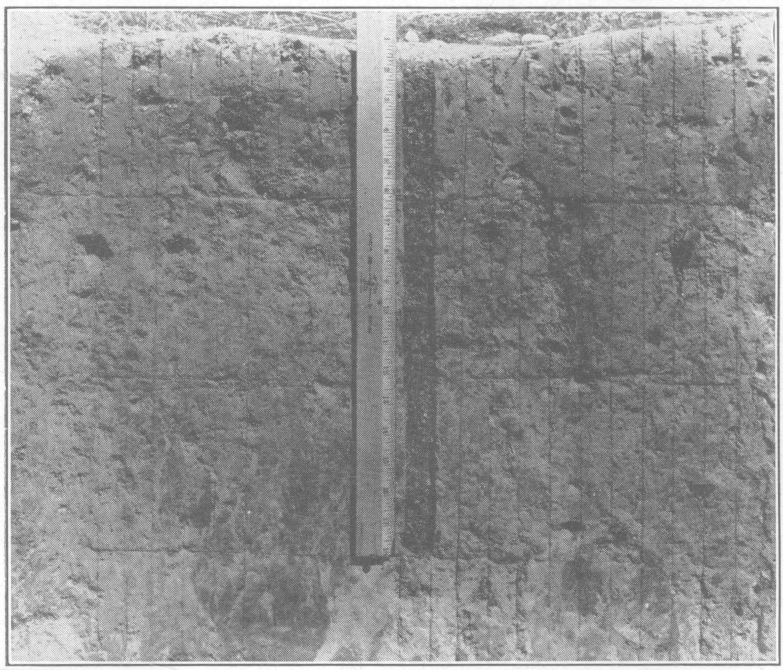
The average yield for the check colonies was 103 pounds of surplus honey, compared with an average yield for the modified two-queen colonies of 126 pounds in one location and 157 pounds in another. The higher yield of 157 pounds per colony was a result of location, as these colonies were in a section where there was a fall honey flow supplied by aster plants.

FRUITS, VEGETABLES, AND FLOWERS

POTASSIUM FERTILIZER SPREADS OUT IN ORCHARD SOIL

To study the lateral spread of potassium and phosphorus in an orchard soil of Wooster silt loam, 1-inch holes were bored 18 inches deep, and the lower 12 inches filled with a mixture of potassium sulfate, superphosphate, and sand. The top 6 inches were filled with plain sand.

After 3 years, soil samples were obtained by digging a trench to expose the core and carefully taking samples at intervals of an inch on each side of the core, and at 6-inch levels.



Soil profile prepared for sampling. Core in center contained the fertilizer salts.

Quick soil tests showed that a large amount of potassium had moved laterally 6 to 8 inches from the core, and these findings were confirmed by quantitative determinations which showed 100 to 200 parts per million of exchangeable potassium 5 to 6 inches from the cores. The untreated soil contained only 30 to 50 parts per million.

In contrast, the phosphorus had not moved more than an inch from the core.

Roots were found in abundance in all the cores examined.

MULCH MATERIAL PRODUCED IN ORCHARD

One of the problems in the operation of commercial orchards under the mulch system is that of securing mulch material at a low cost. As the grass growing in the orchard is an economical source of mulch material, an experiment was conducted at the Belmont County Experiment Farm to determine the effect of cyanamid broadcast between the trees on the production of hay. No special seeding was made; the fertilizer was applied to a mixture of grasses already growing in the orchard, principally bluegrass and timothy.

Weather conditions in 1938 were not favorable for grass growth, yet the 2-year average yield of dry hay was almost 2 tons per acre where 400 pounds of cyanamid per acre were broadcast between the trees. This amount was almost three times as much as produced on the unfertilized plot.

Under the conditions of grass stand and soil found at the Belmont County Experiment Farm, the time of mowing also seems to have a noticeable effect on the yield of dry hay. One strip mowed twice, once in early June and a second time in August, showed a thinning out and decreased growth of material in contrast to the rest of the block, mowed once in late July or early August after grass had matured seed.

RINGING APPLE TREE DOES NOT INCREASE FRUIT SET

Ringing the apple tree has not proved to be dependable as a means of increasing fruit set. This method has been tested particularly with the light-setting varieties, such as Paragon, Arkansas (Mammoth Black Twig), Minkler, and Nero, which frequently fail to produce full commercial crops under the usual orchard conditions. Other varieties, including Stayman Winesap, Turley, Rhode Island Greening, Tompkins King, and Delicious, which, though relatively light in fruit setting, develop full commercial crops under favorable conditions, have also been ringed. During 1939, 118 branches on 27 trees of 11 varieties were ringed during bloom; paired branches were left as checks.

On only a very few branches was the set of fruit increased by ringing; on nearly all there was either no increase or a slight reduction. These results substantiate those of previous years. As a result of these tests, it can be concluded that under Ohio conditions, ringing cannot be depended upon to increase the set of fruit in varieties which frequently produce unsatisfactory yields.

APPLE ORCHARD BEST WHEN 15 TO 25 YEARS OLD

In 1939 a questionnaire was sent to 200 Ohio fruitgrowers who were asked to tell which years of the life of an apple orchard are most productive and which years of the life of an apple orchard give the most economical production.

Of the growers answering the first question, 49.6 per cent reported the greatest production between the fifteenth and twenty-fifth years from planting; 20 per cent, between the fifteenth and thirtieth; 25.2 per cent, between the fifteenth and thirty-fifth; and only 5.2 per cent, between the fifteenth and fortieth years from planting.

Of the growers replying to the second question, 75.2 per cent reported the period of most economical production to be between 15 and 25 years from planting; 15.1 per cent, between 15 and 30 years; and 9.7 per cent, between 15 and 35 years from planting.

Production per tree may tend to increase until an orchard is 35 years old, or sometimes older, but growing costs per bushel tend to rise after 25 years from planting. During the 4 years from 1934 through 1937, the cost of spraying apples in the Station orchards on trees 13 to 16 years of age was 11 cents per bushel. On 20- to 23-year-old trees the cost was 9 cents per bushel, and on 42- to 45-year-old trees the cost was 13 cents per bushel. Pruning and picking costs are also greater on older trees than on those in the younger brackets.

GROWER MAY PICK RED STRAINS OF APPLES TOO SOON

The characteristic early coloring of two of the red strains of Delicious, Starking and Richared, has led some growers to pick these red strains before the standard varieties. Tests made in the Experiment Station orchards show that Starking and Richared should be picked at about the same time as the parent variety, Delicious. Experience with Rome Beauty and the red strain, Gallia Beauty, has been similar. The red strains become more highly colored, and color earlier, but they do not mature any faster than the parent strains.

Tests of ripeness have been made in these experiments by measuring firmness of flesh with a mechanical pressure tester.

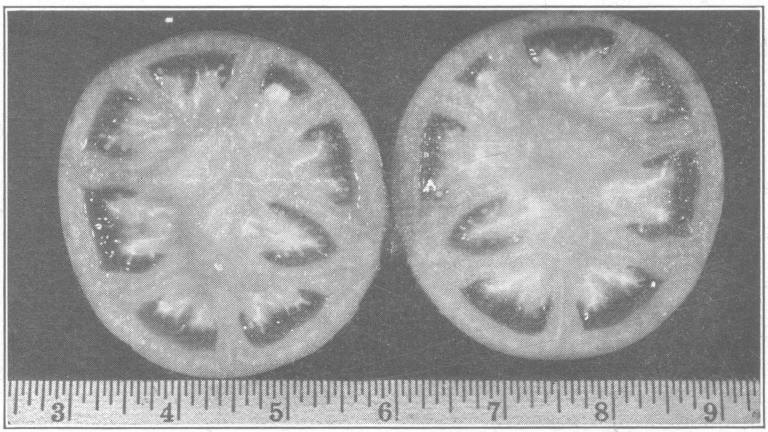
CIDER PRESERVED BY NEW METHOD

Cider has been successfully preserved by pasteurization at 140° F. for 20 minutes after the oxygen had been forced from the cider by bubbling carbon dioxide through it. This cider had a flavor superior to that of any preserved by any previous treatment tried by the Experiment Station.

LARGE SEEDLESS TOMATO FRUITS PRODUCED

Indolebutyric acid in lanum paste applied to the ovary of the flowers resulted in large, seedless tomato fruits on plants in the greenhouse during the fall of 1939. Indolebutyric acid was more effective than other materials tested. Although indoleacetic acid had been fully as effective in inducing fruit development in previous tests, the fruits averaged much smaller in size than fruits produced from self-pollinated flowers. Indolebutyric acid not only produced practically the same set of fruits as was obtained from pollinated flowers, but fruits fully as large. In addition, the fruits contained a large proportion of gelatinous pulp for fruits which do not contain seeds; the amount apparently depends somewhat upon the extent to which the ovules enlarged. The fruits were mild in flavor and appeared to be more solid and less acid than the fruits with seeds. In general, the texture and flavor were similar to those of ordinary tomatoes produced during February and March in the greenhouse.

The most effective concentration of indolebutyric acid in this series was 0.5 per cent in lanum paste. At lower concentrations, 0.1 and 0.02 per cent, the size of the fruits and the proportion produced were correspondingly less. Injury to the fruits was rather severe at concentrations of indoleacetic above 0.5 per cent.



Fruit produced as result of applying indolebutyric acid to Marhio tomato flower

The flower was emasculated and 0.5 per cent indolebutyric acid in lanolin was applied October 2. The fruit was picked November 18 and weighed 218 grams.

THE AMOUNT OF FERTILIZER AFFECTS YIELD OF GREENHOUSE TOMATOES

Based on experiment and practice, the recommended quantities of fertilizers per acre for the spring crop of greenhouse tomatoes in Ohio are 1,000 pounds of 20 per cent superphosphate, 750 pounds of 50 per cent muriate of potash, and approximately eight applications of nitrate nitrogen. The phosphate and potash are worked into the soil along with 50 to 60 tons of manure when the ground is prepared. The nitrogen is applied as side-dressings of 250 pounds of fertilizer per acre every week or 10 days during the fruiting season from the time the tomatoes on the lower cluster are approximately half grown. Commonly, about one-third of the nitrate is potassium nitrate and two-thirds calcium nitrate.

In order to determine how much fertilizer could be used profitably, how much would produce injury, and what the nature of the injury would be, an experiment has been conducted for 3 years. The usually recommended quantities have been taken as the standard treatment and plots set up in which the treatment was adjusted to one-half, three-fourths, one, one and one-half, two, three, and four times the standard. The largest yield in both numbers and weight of marketable fruits was with the standard treatment. The smallest yield was from one-half the standard treatment, and three-fourths of the standard produced intermediate amounts. All the treatments above the standard produced less fruit, and the yield declined in proportion to the size of the application of fertilizer. The size of plants and the numbers and size of fruits decreased, and the amount of blossom-end rot increased.

CONDITION OF SOIL AFFECTS FOOD VALUE OF TOMATO

A recent study at the Ohio Agricultural Experiment Station has emphasized the new idea of a relationship between the food value of the crop and the fertility of the soil.

Tomatoes grown on poor soils were frequently low in minerals and certain vitamins. The plants were deficient in minerals long before the symptoms showed externally, and the lack was observed only on analysis. The nitrogen content of the tomato fruits varied when the amount in the soil was changed. It also varied when the moisture level of the soil was altered, and it varied somewhat in proportion to the carbohydrate supply with changing seasons. The calcium and potassium levels within the fruits varied with the soil treatment, but phosphorus did not except under starvation conditions, when it decreased.

Vitamin C was often much reduced by low potash and low moisture levels in the soil. It was increased by correcting the deficiencies, but excessive fertilization did not increase it much beyond the normal quantity characteristic for the variety. Excessive moisture even decreased the amount of vitamin C if the soil was too wet to permit adequate aeration.

NEW GREENHOUSE VEGETABLE VARIETIES DEVELOPED

The Station's greenhouse vegetable breeding project has produced a strain of Globe tomato known in the Cleveland area as Association Globe. It is generally used by the greenhouse growers. A newer selection, strain A Globe, which is more uniform in size and appearance seems to be replacing the Association Globe, however. The original Marhio and an improved strain have also been developed. The new strain does not have the determinate habit and has deeper and smoother fruits with small stylar scars. At present, there are nearly 200 tomato selections and crosses on trial to find still more desirable strains for greenhouse use. A large number of the selections are from seedlings which were treated with colchicine in the hope of inducing special strains for specific purposes.

The cucumber breeding work has resulted in a number of inbred lines, hybrids, and selections within varieties. Some of the hybrids bear well and have good quality fruits. Two strains of long and medium-long fruits have been developed from a Cleveland strain known as Danish and are ready for commercial trial.

The leaf lettuce which was developed several years ago for tipburn resistance is being reselected to improve this desirable characteristic. Several selections have been made and are now being grown in greenhouse trials for observation.

DIRECT-SEEDED TOMATOES INFERIOR TO TRANSPLANTS

Direct-seeded tomatoes yielded 10.8 tons per acre compared with yields from transplanted seedlings of 16.9, 17.8, and 17.0 tons per acre on fertile irrigated soil at Columbus during the 1939 season. The seed was sown in the field on April 27, and the plots were irrigated. By May 10, the seedlings appeared. They were apparently uninjured by two light frosts. The transplanted seedlings were set in the field on May 16. It was necessary to dust direct-seeded

plants on May 22 to protect them against flea beetles. The transplanted seedlings produced approximately 4 tons per acre before the direct-seeded lots had any ripe fruit.

MIDSUMMER STANDS ON MUCK SOILS NOT UNIFORM

One of the difficulties encountered in field plot tests on muck soils in midsummer is that of securing a uniform stand of plants from plot to plot. With irrigation the stand is improved but still is not as uniform as desired. For example, a count of beet seedlings on equal-sized areas on 12 differently fertilized plots showed an average of 43.5 per cent more plants on the irrigated areas, but the count of seedlings from plot to plot was highly variable.

Most crops seeded in early spring give satisfactorily uniform stands, but onions usually exhibit considerable variability. Stand counts on uniformly treated replicated plots showed a variation of 20 to 34 per cent even where the onions were seeded thickly and thinned by hand.

EARLY VEGETABLE CROPS NEED DIFFERENT AMOUNTS OF NITROGEN

For 24 years a fertilizer experiment with four early vegetable crops has been conducted at the Washington County Truck Crops Experiment Farm on terrace soil of the Muskingum River. Since 1931, the experiment has been arranged to show, among other things, the effect of increasing amounts of nitrogen fertilizer.

As anticipated, omitting nitrogen from the fertilizer resulted in distinct symptoms of nitrogen deficiency in the plants and correspondingly low yields. Eighty pounds of nitrogen included in the initial fertilizer mixture proved sufficient for tomatoes, but the other three crops responded to additional nitrogen applied as side-dressings. The side-dressings were not all applied at the same date, but were applied at times deemed suitable for the individual crops. The first side-dressing increased the average yield of cabbage and cucumbers. On sweet corn, the last side-dressing, applied in July, had more effect than the other applications. The side applications were, of course, more effective in cool, rainy seasons than in warm, dry seasons. Eight-year average yields show clearly that the four crops differ in their nitrogen requirements.

RIGHT FERTILIZERS GIVE BIG POTATO YIELDS

Ever since the Experiment Station was established at Wooster in 1894, fertilizer experiments have been conducted with potatoes. The original work was planned as a 3-year rotation of late potatoes, wheat, and clover. In the course of 40 years it became evident that this rotation was not particularly suited to potatoes; the average yield of the most heavily fertilized plots was less than 200 bushels per acre. In 1936 the rotation was changed so that early seeded rye, as a winter cover crop, preceded the potatoes. The fertilizer treatments were also modernized, and, because of the increasing interest in early potatoes, Irish Cobblers were grown instead of a late variety.

With this new program the yields have been much higher than before, exceeding 300 bushels per acre each year on all the plots with over 1,000 pounds of fertilizer per acre. An interesting finding was that 1,000 pounds of 8-8-8

fertilizer did not supply enough phosphorus or potash for maximum yields. The results suggest that to obtain yields of over 350 bushels per acre on soil of this type, the fertilizer required is approximately 1,000 pounds per acre of 8-12-12.

FERTILIZATION AND QUALITY OF POTATOES RELATED

Potatoes grown on soil heavily fertilized with phosphate and potash were freer from vascular and stem-end discoloration than those grown on unfertilized plots or on plots where one of these two fertilizers was omitted. On the plots with complete fertilizer, 29 per cent of the tubers were discolored; on plots with potash omitted, 68 per cent were discolored.

The discoloration was not due to boron deficiency, as the tubers were found to contain 10 to 13 parts per million of boron. No consistent differences were detected between the phosphorus, iron, calcium, or potassium contents of discolored and normal tubers. The dry matter and manganese content of healthy tubers were slightly higher than those of discolored tubers. No difference in the vitamin C contents of tubers from the different fertilizer plots was discovered.

SWEETEST MUSKMELONS CONTAIN MOST VITAMIN C

Muskmelons containing the most sugars also have the highest vitamin C content. In tests at the Station, the Market King variety had the highest sugar content and a vitamin C content of 0.569 milligram per gram. The Improved No. 45 variety had the lowest sugar content and only 0.159 milligram of vitamin C per gram.

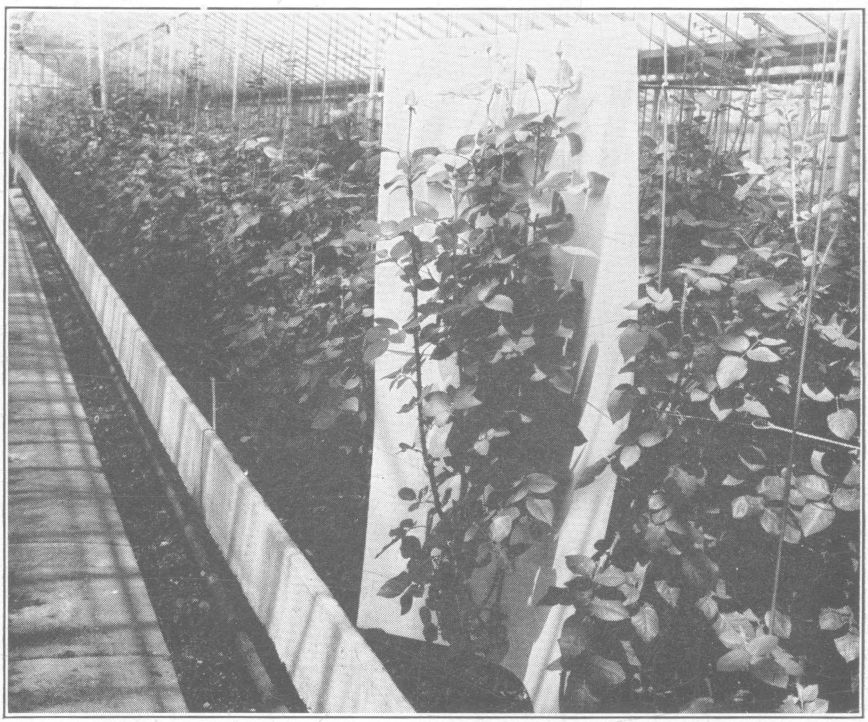
FLOWERS GROW WELL IN GRAVEL AND CINDER CULTURE

Experiment Station investigations during the past 3 years have shown that flowers can be grown satisfactorily in gravel or cinders flushed periodically with a nutrient solution. The best setup for this type of work consists of waterproof concrete benches sloping 1 inch per 100 feet with 6- or 8-inch sides and a V-bottom. In the bottom of the V are several openings connected by a 1-inch black iron pipe to the pump to facilitate drainage. Half-tiles are laid the length of the bench at the bottom of the V for a solution channel. Concrete tanks to hold the nutrient solution are located under the bench. The pump and motor are operated automatically by a time clock.

A nutrient solution giving satisfactory results has been made from commercial grades of potassium nitrate, ammonium sulfate, magnesium sulfate, calcium sulfate, and a food grade of monocalcium phosphate free of fluorine. Iron and manganese were added in the sulfate form at 4 ounces and 1 ounce per 1,000 gallons, respectively. The pH was adjusted with 2 per cent sodium hydroxide or sulfuric acid solution to suit the specific requirement of the crop.

Most flower crops can be grown in Haydite, cinders, calcareous gravel, or silica gravel, but crops requiring an acid soil did not thrive in calcareous gravel. Particles of gravel or cinders between three-eighths and 1 inch in diameter proved most satisfactory.

Both carnations and roses grown in gravel with nutrient solutions produced more flowers per plant and more flowers with stems 12 inches or longer than plants grown in soil.



Roses growing in C Media Haydite on a 2WP solution

A number of tests and observations were made on plants grown in cinders and gravel. Introduction of rotenone, pyrethrum, or selenium for pest control proved unsatisfactory. Mercury and copper compounds were not satisfactory for sterilizing the media. Growth substances (tryptophane, indolebutyric acid, thiourea, and Photosensin) did not increase growth in gravel culture. Cinders containing excess boron were made usable by adding commercial sodium silicate at 10 cubic centimeters per 100 gallons of solution. Dusting crops with sulfur lowered the pH of the solution. Crops transplanted with a 2½-inch ball of soil to a V-bottom bench were not checked in growth, but removing the soil delayed development of plants about 4 weeks. Cut flowers from gravel kept as well as those from soil. Approximately the same amount of water was used for gravel culture as for soil. A high ammonium content in the solution during summer prevented roses from developing from a pinch or cut. Ammonium hydroxide, potassium hydroxide, and trisodium phosphate could be used to raise the pH, and phosphoric acid to lower it. In order to prevent root injury, it was necessary to flood the media with water while the plants were sprayed with insecticides. Flushing at night was unnecessary. During dark weather in winter, one flushing per day was usually sufficient. Additions of 1 part per million of boron and copper increased production on Better Times roses growing in Haydite with the 2 WP solution developed by Station floriculturists.

TOO MUCH FERTILIZER INJURES PLANTS

In order to see whether plants could get too much fertilizer, a wide variety of floricultural crops was grown in pots, and applications of commercial fertilizers carrying the element concerned were made weekly until symptoms of injury from excess of the element appeared.

Nitrate nitrogen.—With too much nitrate nitrogen, growth became stunted and flowers smaller. Basal leaves became chlorotic, and then the chlorosis generally moved upward. Wilting occurred especially on sunny days.

Ammonium nitrogen.—Symptoms of too much ammonium nitrogen were similar to those caused by an excess of nitrate nitrogen. Leaves generally had a dark bluish-green color before becoming chlorotic.

Treble superphosphate.—Growth was generally better on plants to which an excess of treble superphosphate was added than on untreated plants in the early stages, but later the older leaves showed browning at the margins followed by a parchment-like appearance. Plants with the excess fertilizer matured earlier than untreated checks.

Potassium.—Symptoms of potassium excess were very difficult to distinguish from those caused by excess of nitrate nitrogen.

Boron.—Better Times roses showed browning of the teeth of the leaflets on the older leaves when too much boron was added. Irregular interveinal brown spots appeared, followed quickly by a general chlorosis and abscission of the leaflets in which the midrib often remained attached to the stem. The injury progressed upwards rapidly with high concentrations.

Zinc.—With an excess of zinc, Better Times roses gave symptoms of toxicity in the form of water-soaked interveinal areas on older leaves near the midvein. The transparent areas remained light green, and general chlorosis of the remainder of the leaf quickly followed. Leaflets usually became brown and abscised.

TESTS WITH FLOWERS IN CLOTH HOUSE CONTINUED

During the year, Station floriculturists continued their experiments with flowers growing in cloth houses. Among others were shading tests with black sateen, rubberized cloth, and aluminized cloth on chrysanthemums. No significant differences in temperature under the three cloths were noted. The varieties Carlina Lee, Roman Bronze, and Nellie Kleris faded uniformly under all the cloths.

Mulching with shredded tobacco stems and leaves gave no significant benefit. Additions of Dow Stimulant at the rate of 10 pounds per 100 square feet were detrimental to chrysanthemums and asters. The use of DN dust as an insecticide for asters and pompon chrysanthemums was unsatisfactory, resulting in severe burning.

SOLUTIONS PROLONG LIFE OF CUT FLOWERS

A number of solutions have been tested by Station floriculturists for their effect on the keeping quality of cut flowers. The following three were effective in prolonging the life of most species:

One ounce of hydrazene sulfate dissolved in a quart of water; one teaspoonful of this solution plus one tablespoonful of sucrose per quart of water

One-fourth teaspoonful of potassium aluminum sulfate (alum) plus one tablespoonful of sucrose per quart of water

One gram of Santomerse penetrator plus one tablespoonful of sucrose per quart of water

PROPAGATION OF ORNAMENTALS STUDIED

Extensive propagation studies have been carried on during the past year to determine the value of synthetic growth-promoting substances for stimulating root formation.

Tests on grafts.—*Juniperus virginiana* and *J. horizontalis* grafting stocks were severely injured by treatment with indolebutyric acid in solution (2 milligrams or 4 milligrams per 100 cubic centimeters of water for 24 hours) and with a heavy coating of dusts containing growth substances.

Cions of *J. chinensis columnaris glauca, virginiana cannarti,* and *virginiana keteleeri* soaked in indolebutyric acid at 3 milligrams or 5 milligrams per 100 cubic centimeters of water for 24 hours gave poorer results than untreated cions.

Indolebutyric acid in lanolin applied at the union showed some promise.

Tests on cuttings.—Hardwood cuttings did not respond favorably to treatments with growth substances applied either before or after callusing.

Treatment of cuttings of deciduous and evergreen plants with synthetic growth substances increased the percentage of rooting over untreated cuttings, based on the length of time the cuttings were left in the bench, decreased the time required to reach the normal rooting percentage; and produced root systems which were superior to those developed on untreated cuttings.

In general, plants difficult to propagate by cuttings were not benefited by treatment to the extent of making the practice commercially feasible, however.

The external position of roots on plants which exhibit specific rooting habits was not changed by applications of growth substances.

Cuttings of narrow-leaved evergreens made in January were more responsive to growth substances than those taken in November.

Growth substances incorporated in talc were nearly as effective as those in solutions and at the same time were easier to apply, were stable over a greater length of time, and possessed a wider latitude of effectiveness and safe use.

Cuttings treated with growth substances showed a greater tolerance to varying environmental conditions than untreated cuttings.

Although free acids of growth substances are in general more effective, the amides showed considerable promise. They are more stable and are less apt to injure cuttings.

Dipping the cuttings in water before treatment was beneficial and was more effective than dipping in alcohol.

CHLOROPICRIN TREATMENT TESTED

Chloropicrin (tear gas or larvacide) is being advocated for sterilizing soil and for control of weeds both under field and greenhouse conditions. In answer to requests from growers, a number of tests were conducted on its use; the following results were obtained:

The gas had little or no effect on soil reaction or on the content of available phosphorus and potash.

Used at the rate of 7 cubic centimeters per square foot it increased the nitrogen content above that of steam-sterilized soil.

Considerable variation was found in the effect of the gas on germination of seeds. Seven to ten cubic centimeters per square foot reduced germination of Poppy (*Papaver nudicaule* Express) and a variety of the Compositae and Scrophulariaceae families. Five to ten cubic centimeters per square foot gave increased germination with other members of these families and with carnation, pansy, and *Alyssum argenteum*.

In general the gas treatment increased the growth of plants. The weight of pansy on untreated soil was 0.8 gram; on soil treated with 7 cubic centimeters of chloropicrin per square foot, 1.1 grams; and with 10 cubic centimeters, 1.2 grams.

In control of weeds and fungi, the tests were not conclusive, but they indicate that the gas had some value.

SOIL REACTION HAS LITTLE EFFECT ON OUTDOOR ROSES

Roses were planted in the spring of 1937 on plots adjusted to definite soil reactions. The plots had a pH of 5.0, 6.0, 6.5 (check), 7.0, and 8.0 and were maintained at these points as uniformly as possible during 1937, 1938, and 1939. In 1938 the plots tested slightly more acid than in 1937, but were relatively uniform and were at the correct points during 1939. The soil reaction had very little effect on the yield of roses.

Other plots were given ½ to 1 pound per 50 square feet of magnesium, manganese, and zinc salts. Borax was applied at the rate of 20 grams per 100 square feet. These plots were at pH 6.5 during 1939. During the 3-year period, the zinc, manganese, and magnesium plots were consistently among the five highest yielding.

DAIRYING

FEED COSTS DROP AS MILK PRODUCTION GOES UP

Up to a certain level, the feed cost of producing 100 pounds of milk drops as production rises. When the records of a study planned to show dairymen how much feed is required to produce 100 pounds of milk were grouped into divisions according to yearly butterfat production, starting with 200 pounds and increasing at 50-pound intervals, it was found that the amounts of feed needed for 100 pounds of milk decreased until the 350-pound fat level was reached, but that above this level there was little change.

Actual feeds required to produce 100 pounds of 4 per cent milk were:

Fat level	Average amount of 4 per cent milk produced	Feed per 100 pounds of 4 per cent milk		
		Grain	Hay	Pasture
	Pounds	*Pounds*	*Pounds*	*Days*
Under 249	5,390	48	77	1.7
250–299	6,796	40	69	1.5
300–349	8,100	39	64	1.4
350–399	9,175	35	55	1.0
400–449	10,211	35	54	.9
Over 450	11,806	33	52	1.2

The figures for hay include all roughages fed, calculated to a hay basis.

GOOD HAY AND PASTURE REDUCE GRAIN BILLS

Results of a test being carried on at the Trumbull County Experiment Farm indicate that dairymen who make maximum use of good hay, and pasture in season, may be able to save on their grain bills.

In this test, two groups of purebred Holsteins receive all the hay they can eat and abundant good pasture during the pasture season. One group receives in addition 1 pound of grain to 4 pounds of milk produced; the other, 1 pound of grain to 6 of milk produced. Both groups get 20 pounds of corn silage a cow daily during the winter.

During the last 18 months, production has been about the same for both groups, and there have been no marked differences in general health and reproduction between the two groups.

CARROTS CAN BE STORED AS SILAGE

Carrots make an excellent dairy feed and might be expected to keep the yellow color in milk at a fairly high level during the winter. Often, however, lack of storage facilities makes it impossible to feed carrots during the winter season.

Seeking a way to store carrots for winter feeding, Experiment Station dairymen thought of the possibility of ensiling them with some crop which in itself might make silage low in carotene. As a result, field carrots were ensiled with overmature corn having a high percentage of dry matter and bleached leaves and, hence, a low carotene content.

The carrots were fed into the cutter at as nearly a uniform rate as possible along with the corn. About 1 ton of carrots and tops was used for each 2.25 tons of corn.

After 2 months, the silo was opened. The silage was in good physical condition, had a pleasant silage odor, and an acidity comparable to that commonly found in corn silage. Contrary to what might be expected, the chopped pieces of carrots still had what appeared to be their original physical condition.

To determine its feeding value, the corn-carrot silage was fed to a group of cows for 40 days and compared with good corn silage fed on an equal dry-matter basis to a comparable group of cows. Both groups received, in addition to silage, alfalfa hay fed according to liveweight and a grain mixture fed at the rate of 1 pound to 3 pounds of milk produced to Jerseys and 1 to 4 pounds of milk to Holsteins. At the end of 40 days the silages were reversed; the corn silage cows were given corn-carrot silage, and vice versa. Feeding was continued in this manner for 46 days, the first 6 of which were considered preexperimental, and the data from 40 days were used. The corn-carrot silage was found to be highly palatable.

Milk and butterfat production on the two silage rations was practically identical, and, since the food intake was carefully controlled, it can be concluded that the corn-carrot silage was equal to the corn silage for milk production. The cows receiving corn silage gained a little more weight than those receiving the corn-carrot silage.

More carotene, shown by greater depth of yellow color, was found in the butterfat produced when the corn-carrot silage was fed than when the corn silage was fed, and this result was in keeping with chemical analyses of the silages for carotene. The corn silage contained 54.3 and 80.4 parts per million of carotene (ovendry basis) during the first and second periods, respectively, and the corn-carrot silage, 76.9 and 108.9 parts per million of carotene during comparable periods.

WHEAT AND ALFALFA MAKE GOOD SILAGE

Wheat was seeded at the rate of 1 bushel per acre in alfalfa which had been seeded the previous year and had made a rather thin, uneven stand. The wheat and alfalfa grew well together and the crop was harvested for silage June 8 and 9, 1939. When the silage was harvested, the grains in the wheat were about one-half size and still green in color; the alfalfa was coming into bloom. The dry-matter content of the crop was about 27 per cent. The proportion of wheat to alfalfa was estimated to be about 2 to 1.

The crop was cut with the binder, except the first few rounds. Cutting with the binder made it much easier to handle and it was chopped finer in the cutter. The yield of green material was 7.25 tons per acre.

This silage did not pack as well as alfalfa or clover silage; there was too much wheat in proportion to alfalfa. The top was covered with building paper and weighted with bags of sawdust. The silo was opened on July 20, 40 days after filling. A little less than one-half ton at the top was spoiled, and almost none in the center at the top. There was some mold down the sides caused by the poor condition of the silo. Generally, the silage was good and fairly palatable considering the large amount of wheat straw it contained. As it went into the silo, the carotene content was 214.2 parts per million; as it came out, 101.8 parts. The acidity was a little lower than expected.

This silage was fed to cows on pasture in comparison with alfalfa hay. Fourteen cows were paired in two groups of seven each. During a 40-day period on pasture the two groups averaged the following consumption and production in pounds:

	Grain	Silage	Hay	Milk	Fat
Silage group	352.7	10,235		1,387.5	51.9
Hay group	359.4		425.5	1,395.4	53.9

Slightly more dry matter was consumed in the hay, but the difference was so small that the silage and hay seemed equal as pasture supplements.

GROUND CORN TESTED AS A SILAGE PRESERVATIVE

To determine the value of ground corn as a preservative for legume silage, two small silos were filled with a crop consisting of alfalfa and clover. One hundred pounds of ground shelled corn were added per ton of material as a preservative in one of the silos. Nothing was added to the material in the other silo.

These silos were opened 58 days later. The silage was good in both. No more acid had developed in the one treated with corn meal than in the other, as indicated by the pH, and the untreated silage was as palatable as the treated. In the untreated, the carotene was 191.9 parts per milligram, in the treated, 188.5 parts, or practically the same. This one test showed no benefit from adding the corn, but further work is necessary to check these results.

ARTIFICIAL SUNLIGHT NO CONTROL FOR BANG'S DISEASE

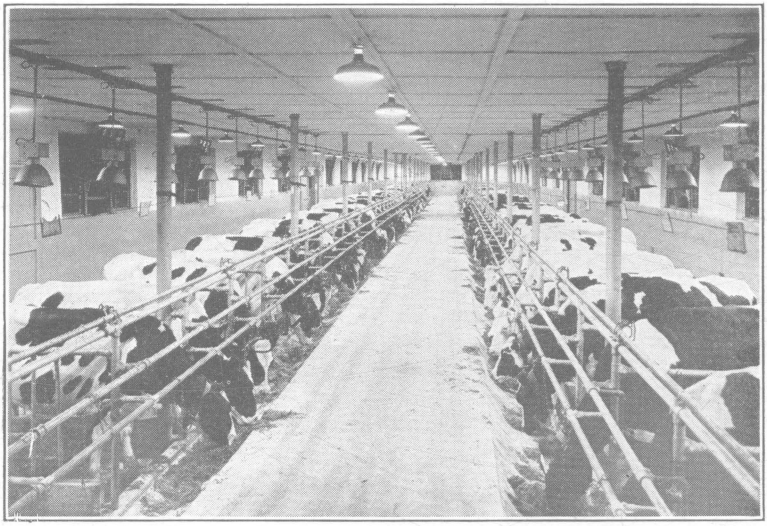
Artificial sunlight produced as ultraviolet rays from sunlamps has failed to have any significant effect on the course of Bang's disease.

Cows classed as nonreactor, questionable, and reactor on the basis of agglutination tests run in 2 successive months received the equivalent of 100 hours of midsummer sunshine in addition to natural sunshine for 1 year and about 300 hours of irradiation the second year. The sunlamps were placed to give maximum exposure on the head region. Through these 2 years, some changes occurred in agglutination tests, but reactor cows never became negative.

Although the light sources used in this herd failed to alter the course of Bang's disease, it should be pointed out that the ultraviolet light used did not include the sterilizing wave lengths.

IRRADIATING COWS DOES NOT INCREASE PRODUCTION

In order to see what effect artificial sunlight in winter would have on milk production, the irradiated cows in the Bang's disease test were compared with a group of cows that received no artificial sunlight. During the 2 years, the average daily production of 4 per cent milk for the irradiated cows was 32.4 pounds, for the cows that received no artificial sunlight, 31.9 pounds—no significant difference.



The ultraviolet lamps used in the experiment are arranged over the near end of each line of cows; they are not lighted in this picture.

Two more trials were then run. In these, previous production performance and stage of lactation were used as a basis for dividing the cows into groups, one of which received irradiation equivalent to about 10 hours of midsummer sunshine; the other, no artificial sunlight. In the first of these trials, which lasted 91 days, irradiated cows produced three-fourths of a pound more of 4 per cent milk daily than those not irradiated. In the second trial, over a period of 172 days, the irradiated cows produced a little more than three-fourths of a pound more of 4 per cent milk a day than the others—again no significant difference.

ARTIFICIAL SUNSHINE INCREASES VITAMIN D IN MILK

Although artificial sunshine on cows did not control Bang's disease and did not increase the quantity of milk produced, it did increase the amount of vitamin D in the milk. Milk from cows exposed to ultraviolet light for the equivalent of 12 to 16 hours of midsummer sunshine daily did not, however, contain more vitamin D than that from cows on pasture (50 U. S. P. units per quart).

Aside from demonstrating that artificial ultraviolet light can be absorbed when directed at the back region of cows, these results have doubtful practical value, because milk can easily be enriched with vitamin D by feeding cows irradiated yeast or by adding the vitamin directly to the milk by irradiation or in vitamin D concentrates.

VITAMIN D NO MORE EFFECTIVE IN SOFT CURD MILKS

There has been some question about the effectiveness of vitamin D added to milks varying in curd tension, or softness. To answer this question, normal, homogenized, natural soft curd, and soft curd (base exchange) milks were fortified with the same amount of vitamin D from the same vitamin D concentrate.

Based upon bone ash values in rats fed equal amounts of the different milks, and upon the degree of healing obtained in rats suffering from rickets, no difference in the efficiency of the added vitamin D could be detected.

KEEPING MILK COLD PREVENTS LOSS OF VITAMIN C

Housewives have known for a long time that keeping milk cold would keep it from spoiling, but now they have another good reason for keeping milk in the refrigerator—preservation of its vitamin C content.

In tests at the Experiment Station, pasteurized milk kept in a clear bottle at room temperature lost practically all its vitamin C within 6 hours. When kept in a brown bottle under similar conditions, it lost little in 6 hours, but almost all within 24.

Pasteurized milk kept at 38° F. in a clear bottle lost only 30 per cent of its vitamin C in 48 hours, 52 per cent in 72 hours. The loss from brown bottles was similar during 48 hours and amounted to 40 per cent in 72 hours.

During the course of this test, it was found that milk lost little vitamin C during pasteurization.

YELLOW PIGMENT IN ROUGHAGES IMPORTANT

Vitamin A occurs in plants as carotene, a yellow pigment essential for the normal performance of dairy cattle and for the production of milk rich in vitamin A. The chief source of carotene for cattle is roughage. To determine which kind of roughage furnishes the most carotene for dairy cattle, the carotene content of a number of different crops (pasture, hay, corn silage, grass, and legume silage) has been determined chemically in the green plant in the field, in plants after cutting and hauling to the silo, and in silage made from the crops. The effect of feeding these silages on the carotene content of milk was also studied.

In general, the carotene content of the roughage consumed was reflected in the carotene content of the pooled milk, but considerable variation was found in the ability of individual cows to transmit feed carotene to milk carotene.

Frequently silages were found to contain more carotene than the material from which they were made. No satisfactory explanation for this has yet been found.

VITAMIN A DEFICIENCY DAMAGES REPRODUCTIVE ORGANS

Recent investigations indicate that vitamin A deficiency is one of the causes of failure of reproduction among farm animals. Physical symptoms shown by farm animals suffering from vitamin A deficiency are so variable and confusing, however, that it is hard to diagnose this deficiency correctly. In order to make a correct diagnosis of any disease, it is necessary to understand thoroughly the way the germ or, as in this case, the nutritional deficiency, acts to cause the disease.

One of the symptoms found with striking regularity in vitamin A deficiency is a degeneration of the germinal epithelium of the gonads, particularly in males. The reciprocal relationship known to exist between the gonad and the pituitary gland has led research workers to assume that the deficiency might

act directly and cause damage to the gonads or that it might act indirectly through the endocrine relationship to cause the gonad to cease to function because of a damage to the pituitary.

Work done by Experiment Station dairy specialists on the relation of vitamin A deficiency to failure of reproduction in rats has added weight to the theory that vitamin A deficiency causes failure of reproduction by causing damage directly to the gonads.

Preliminary experiments on calves have shown that vitamin A deficiency causes degeneration of the germinal epithelium in the testes and microscopic changes in the pituitary.

VITAMIN D MILKS TESTED FOR VITAMIN CONTENT

During the period from July 1, 1938, through June 30, 1939, 176 samples of commercial vitamin D milk were tested to see whether they contained the standard amount of vitamin D. Twelve samples, or 6.8 per cent, were below the standard of 400 U. S. P. units per quart for fortified and metabolized milks and 135 U. S. P. units for irradiated milks. Only 3 of the 12 samples were seriously below the standard, however.

Results of tests on vitamin D milk

Method of increasing vitamin D	Number of assays	Standard or above	Below standard
The feeding of irradiated yeast (metabolized)	19	19	0
The addition of vitamin D concentrates to milk:			
Vitex	94	90	4
UVO	15	12	3
Sun-A-Sured	12	12	0
A.R.P.I.	24	21	3
DeLiquid Concentrate (Campsi)	8	8	0
Irradiation of milk with ultraviolet light	4	2	2
Totals	176	164	12

LIVESTOCK AND POULTRY

HYBRID CORN AS GOOD AS OPEN-POLLINATED FOR FATTENING STEER CALVES

In a test conducted during 1939, 20 steer calves fattened on hybrid corn outgained 20 steer calves fattened on open-pollinated corn. During the feeding period, the calves fed the open-pollinated corns gained an average of 1.91 pounds daily; those fed the hybrids gained 1.97 pounds. During seven of the eleven 4-week periods, the average daily gains were larger on the calves fed the hybrid corn.

It was found that 536 pounds of the open-pollinated shelled corns were required for 100 pounds of gain on the calves but that 519 pounds of hybrid shelled corn produced 100 pounds of gain. This difference, approximately 3 per cent, is in keeping with the difference in rate of gain.

There was no apparent difference in palatability between the hybrid and open-pollinated corns.

Calves weighing 350 pounds were used in the test, which started in January and closed in November after a feeding period of 308 days.

K23, W17, Iowa 939, and U. S. 52 were the hybrids used. Farms were located where one of these hybrids and an open-pollinated corn recognized as popular in the community had been grown during 1938 in the same field under similar cultural conditions and in sufficient quantity to meet the requirements of the test.

A selection of Clarage had been grown along with K23; another selection of Clarage had been grown along with W17; Woodburn had been grown with Iowa 939; and Golden Delight with U. S. 52. The corns were stored as ear corn, and about a 2 weeks' supply was shelled at a time until June, when the remainder was shelled and placed in bins.

The corn was fed as shelled corn, and the same amount per day per calf was fed in each lot. The four hybrid corns were mixed together in equal parts and fed to the calves. The open-pollinated corns were handled in the same way. Silage was fed to each lot at the rate of 7 pounds per calf per day. A supplement containing about 45 per cent of protein was fed at the rate of 1.5 pounds daily per calf, and mixed clover and timothy hay was fed in such amounts as the calves would eat. During the first few weeks, this amount was 2 pounds per day; for the remainder of the test, 1.5 pounds per calf per day.

The moisture content of the corn was determined each 4-week period. For the entire period the moisture content of the open-pollinated corns averaged 15.28 per cent. The hybrid corns averaged 15.66 per cent. The corn consumed was calculated to a basis of 15.5 per cent moisture in reporting the amount eaten and the amount of feed necessary to produce a hundred pounds of gain.

CANE MOLASSES HAS VALUE AS A PREVENTIVE FOR APOPLEXY OF LAMBS

Recent work at the Ohio Agricultural Experiment Station indicates that the feeding of cane molasses has value as a preventive of so-called "apoplexy" or "overeating disease" of fattening lambs.

During the lamb feeding season of 1937-1938, and again during that of 1938-1939, an experiment was conducted to study the influence of various concentrates in the ration on the occurrence of this disease. The results of these two experiments showed that a lot of lambs fed 0.3 pound of cane molasses daily per lamb in addition to a ration of corn, protein supplement, legume hay, and silage suffered only about one-fourth the death loss from apoplexy that occurred in a comparable group fed the same ration without molasses.

Encouraged by these results, Station animal specialists conducted a test during the 1939-1940 feeding season to gain additional information on the value of adding molasses to lamb rations for the prevention of the disease. Four comparable lots of lambs, each containing 69 white-faced western feeding lambs were fed a ration of shelled corn (full-fed), 0.15 pound of protein supplement, about 1 pound of alfalfa hay, and 1.25 pounds of corn silage daily per lamb. This ration without any addition was fed to lot 1. Over a period of 91 days, 11 lambs in this group died from apoplexy. Lot 2 lambs were fed 0.3 pound of cane molasses daily per lamb in addition to this ration. During the same 91-day feeding period there was no loss from apoplexy in this group. Lot 3 lambs were fed half as much cane molasses as the lot 2 lambs, or 0.15 pound daily per lamb, and one lamb in the group died from apoplexy. Lot 4 lambs received the basal ration until a typical apoplectic death occurred, and then 0.3 pound of cane molasses was added to their ration. From the time the cane molasses was added until the lambs were sold, a period of 46 days, no further losses occurred.

From these experiments, which are substantiated by reports from commercial lamb feeders who have followed the Station's suggestion to feed molasses to lambs suffering from apoplexy, it seems that cane molasses must be credited with some therapeutic value against this disease. Whether other molasses or molasses mixed feeds have the same therapeutic value is as yet undetermined.

From a corn-replacement standpoint, a pound of cane molasses is not equal to a pound of corn in producing gain on lambs and, hence, has a value from this standpoint lower than corn. In these experiments, involving apoplectic losses, the value of the lambs that died as a result of apoplexy in the lot without molasses would have purchased more than four times as much molasses as was fed to lot 2 to prevent apoplexy and 8.5 times as much molasses as was fed to lot 4 lambs for the same purpose.

Apoplexy does not, of course, affect lambs in all feed lots. Some lamb feeders have had no experience with it, though others have suffered losses varying from a few lambs up to 25 per cent or more of their flock. The question is, then, when should molasses be fed? The Station's experiments furnish a basis for suggesting that lamb feeders whose lambs are not affected cannot afford to feed molasses unless they can buy it for the same price as or a little less than an equal weight of corn. On the other hand, where apoplexy has caused losses regularly or where apoplexy makes a sudden appearance, lamb feeders can scarcely afford not to try molasses for its seeming therapeutic value against the disease.

Laboratory work is in progress which deals with the pathology and bacteriology of an organism which seems closely associated with the disease. As this work progresses it is hoped that more of the details will be known concerning apoplexy, which has been so troublesome to lamb feeders for so many years.

WIDE VARIETY OF FEEDS TESTED FOR PIGS

During the year, swine specialists at the Ohio Agricultural Experiment Station carried on a variety of experiments, including trials with hybrid corns, liver meal, and a number of protein concentrates.

MIXTURES OF PLANT AND ANIMAL PROTEINS EFFICIENT

As measured by the feed required per pound of gain produced, when they were fed with corn, ground alfalfa, and minerals to pigs in dry lot, mixtures of equal weights of tankage and linseed meal, of tankage and iron-treated hydraulic cottonseed meal, of tankage and expeller soybean oil meal, and of three animal and three plant protein feeds differed less than 2.25 per cent in their efficiency. The pigs fed the mixture of tankage and linseed meal and those fed the mixture of tankage and cottonseed meal were ready for market about 2 weeks earlier than the others.

IRON-TREATED COTTONSEED MEAL NOT TOXIC

Untreated and iron-treated standard hydraulic, pre-pressure cooked hydraulic, and pre-pressure cooked expeller cottonseed meals were fed to pigs as the protein concentrate. None of the 30 pigs fed the 3 kinds of iron-treated meals died, whereas of the 30 fed the same 3 meals untreated, 20 died. Pre-pressure cooking of the cottonseed meats before they were pressed did not overcome the toxicity of the meal.

LIVER MEAL GOOD FOR YOUNG PIGS

A meal containing liver and small amounts of other glandular material was used during the growing period to replace an equal weight of tankage in a dry-lot ration of corn, tankage, soybean oil meal, ground alfalfa, and minerals. While fed, it made up 12.4 per cent of the supplement or 2.5 per cent of the total feed. As determined from the feed replaced per unit of gain, its value was 7.2 cents a pound. The pigs that received the liver meal were ready for market 10 days earlier than those without it. Liver meal is rich in riboflavin, nicotinic acid, and other vitamins. Nicotinic acid, included in a ration of yellow corn, soybean oil meal, cod-liver oil, and minerals, resulted in no faster gains and no greater gains per unit of feed consumed.

PIGS PREFER DRIER CORN

Four hybrid and four open-pollinated corns were self-fed separately to a group of pigs. When the corns were ranked according to the amounts of each consumed, indications were not that the open-pollinated corns were more palatable than the hybrids but that the dry corns were more palatable than those high in moisture. There was a close correspondence between the ranking of the corns on a basis of lowness in moisture and on a basis of the amount of each consumed. Likewise, in 9 out of 10 trials comparing hybrid and open-pollinated corns, grown under similar conditions, the pigs that received the drier of the two corns ate more feed daily a head than those that received the corn with the higher moisture content.

ARE PIGS SUBJECT TO PROTEIN POISONING?

Ailments in pigs have sometimes been diagnosed as protein poisoning. In a preliminary study of the effect of an excess of protein, four pigs were fed a ration containing 42 per cent of protein, approximately two and one-half times a normal amount. The pigs averaged 69 pounds at the start and were fed for 13 weeks. They scoured persistently but ate an average amount of feed, gained 1.34 pounds daily a head, and made 100 pounds of gain for each 378 pounds of feed consumed. Veterinarians who examined them and the carcasses at the time they were slaughtered found no harmful effects from the high amount of protein fed.

CHANGING THE PROTEIN LEVEL APPARENTLY WAS NOT INJURIOUS TO PIGS

A group of pigs had access to a mixture of yellow corn, ground alfalfa, and minerals which contained only 8.8 per cent of protein. These pigs were fed for four periods of 4, 4, 3, and 2 weeks. In the second and fourth periods the pigs also had access to a supplemental mixture containing 55 per cent of protein. By periods, the gains were 0.5, 1.44, 0.87, and 2.08 pounds daily a head. The feed requirements per 100 pounds of gain were 661, 304, 578, and 282 pounds, respectively. No ill effects from the change or from the liberal consumption of protein were observed.

MILK BENEFICIAL IN CHICK RATIONS

It is generally conceded that milk in some form is a valuable, if not almost indispensable, ingredient in chick rations. The value of milk in chick rations has, in the past, usually been attributed to its protein and mineral content. More recent investigations have shown, however, that milk products also furnish many of the water-soluble vitamins which poultry need. Among these vitamins, riboflavin, or vitamin G, is of practical consideration, because common feedstuffs do not supply enough of this factor to meet the needs for best growth Riboflavin-rich supplements, such as milk and good quality alfalfa meals, are, therefore, used to make the ration adequate in vitamin G. Because proteins and minerals can usually be obtained from other sources for less money than from milk, it is logical to inquire whether the most important purpose of milk in the chick ration is not to furnish riboflavin (vitamin G) and possibly other vitamins or vitamin-like factors

Experimental work with simple practical rations of yellow corn, wheat middlings, wheat bran, minerals, cod-liver oil, and equivalent amounts of protein from either soybean oil meal, meat scraps, or fish meal with adequate amounts of riboflavin added, showed that the addition of 5 per cent of dried milk or the proteins of such a quantity of milk increased the value of the soybean oil meal and meat scraps rations but not of those containing good quality fish meal as the only source of supplemental protein. These observations indicate that some beneficial effects aside from riboflavin are to be gained from the use of milk in rations in which soybean oil meal and meat scraps serve as the main source of supplemental protein or if only limited amounts of fish meal are used.

PIGS NEED RIBOFLAVIN

Preliminary experiments during the past year have shown that riboflavin is essential in the nutrition of the pig. Pigs fed a synthetic ration free of riboflavin ceased to gain after several weeks, became unthrifty in appearance, exhibited chronic diarrhea, vomited frequently, and gradually lost weight. The addition of adequate riboflavin to the same ration from the beginning of the experiment resulted in approximately normal gains and appearance. Likewise, the feeding of adequate riboflavin to the deficient pigs caused a resumption in growth, improvement in appearance, and disappearance of the diarrhea and vomiting.

FACTORS IN THE VITAMIN B COMPLEX ASIDE FROM VITAMIN B_1 AND RIBOFLAVIN REQUIRED FOR THE NUTRITION OF THE RAT

During the past year, a study has been made of the conditions which affect a change in the color of the hair of piebald rats. If the animal receives sufficient vitamin B_1 (thiamin), riboflavin, and filtrate fraction of yeast extract, there is no loss of color. If the filtrate fraction is replaced with vitamin B_6 or the $Ba(OH)_2$ eluate fraction (factor 1), the hair of the animals turns gray. It has been found that if the filtrate fraction is concentrated and treated with 10 volumes of 95 per cent ethyl alcohol, the vitamin preventing gray hair is found in the insoluble fraction. When the alcohol-insoluble fraction is extracted with ether (after being made strongly acid), the vitamin preventing gray hair goes into the ether fraction. The ether-extracted fraction has lost the properties of preventing gray hair.

From the ether extract, beautiful needle-like crystals have been obtained. These crystals are now being fed, and the results are awaited with interest.

ULTRAVIOLET LIGHT GOOD SOURCE OF VITAMIN D FOR CHICKENS AND TURKEYS

Although fish oils potent in vitamin D are good sources of the vitamin for poultry kept in confinement, especially during the winter months, there is also a need for other sources of vitamin D. It has been known for some time that artificially produced ultraviolet light is an effective source of vitamin D, but until recently, the expense of producing it was prohibitive because of the cost and short life of equipment and the high electric current requirement.

Now, improved, durable, less expensive ultraviolet lamps operating on a low electric voltage are available, and the cost of providing ultraviolet light for poultry is greatly reduced. As a result, the advantages, disadvantages, and practicability of ultraviolet light for poultry are matters of current interest to many poultrymen, especially since the rapid rise in price of cod-liver oil recently due to curtailment of supplies from abroad.

In the Station's experiments, chicks and poults raised indoors showed about the same rates of growth and mortality whether the birds received cod-liver oil or ultraviolet light. For turkeys grown indoors, the ultraviolet source has a distinct advantage. It can be used until the turkeys are marketed, whereas fish oil may give the meat a fishy flavor unless it is omitted 4 to 6 weeks before turkeys are dressed for market.

The experiments with Leghorn and Rhode Island Red layers are still in progress, but the results for the first 5 months were much the same, both in egg production and rate of mortality, with both sources of vitamin D. These experiments started with the layers as day-old chicks.

Artificial light has long been a valuable aid for poultrymen, and the development of new types of lamps and the application of new kinds of light, especially ultraviolet light, offer interesting possibilities for the poultry industry of the near future.

MARKET QUALITY OF EGGS AFFECTED BY HUMIDITY OF EGG-HOLDING ROOM

Producing market quality eggs has raised many new problems for the poultryman and has created the need for new information to deal with these problems. It seems that the solution of one problem often leads directly to another. For example, it was supposed that if the poultryman gathered his eggs two to four times daily and immediately placed them in wire containers in a cool room (40 to 65° F.), these eggs should grade as U. S. Extras when marketed twice a week. However, to the surprise and disappointment of many market egg producers who had carefully complied with these requirements, these eggs went into the U. S. Standard grade all too frequently. Obviously, there was still another factor which was at times determining the market quality of the eggs before marketing.

In cooperation with the Wooster Egg Auction, the Station conducted a series of tests in the egg-holding room at the Station's poultry plant and found the missing factor. It was lack of humidity, or moisture, in the egg-holding room. With increased humidity, the eggs graded as U. S. Extras instead of U. S. Standards. When the humidity was reduced, the eggs again became U. S. Standards. It was repeatedly demonstrated that the quality of U. S. Extras could be maintained or degraded to U. S. Standards at will by increasing or decreasing the percentage of humidity in the egg-holding room.

The installation of a spray nozzle costing 75 cents and a small electric fan provided the necessary humidity to maintain the quality of the eggs so that they could be marketed as U. S. Extras. From this small investment, came increased returns of 20 to 25 dollars per month from the sale of 8 to 10 cases of large eggs a week as U. S. Extras instead of U. S. Standards.

When eggs are sold on the basis of market quality, U. S. Extras generally command 1 to 3 cents a dozen more than U. S. Standards. U. S. Extras averaged 2½ cents a dozen more than U. S. Standards at the Wooster Egg Auction during 1939. Even from a farm flock of 200 to 250 layers, the increased returns from the sale of eggs as U. S. Extras instead of U. S. Standards should amount to 3 or 4 dollars a month—a substantial return from a suitable egg-holding room and the proper care of eggs before marketing.

SEVERAL RATIONS AND METHODS OF FEEDING LAYERS SATISFACTORY

As new information on poultry feeds becomes available and new methods of feeding are discovered, poultrymen ask, what are the best rations and methods of feeding layers for economical egg production? To secure new information on this pertinent question, the Station recently completed a test of three types of rations and three methods of feeding Leghorn layers.

The rations were:

22 per cent protein laying mash supplemented with whole corn and oats
32 per cent protein supplement mash supplemented with whole corn and oats
17 per cent protein whole oats – mash all-in-one complete feed mixture

The methods of feeding were:

Free-choice feeding of whole corn and oats
Free-choice feeding of whole corn and oats restricted to 2 hours daily
Laying mash supplemented with dried milk and moist mash

In all instances the dry mash was kept available for the birds at all times.

All the rations yielded satisfactory results, and all but one of the methods of feeding proved satisfactory. The layers receiving the 32 per cent protein mash supplement with whole corn and oats available only 2 hours daily (2 to 4 p. m.) laid the smallest number of eggs with the highest cost per dozen eggs produced. Of all the groups, the one that received the whole oats – mash mixture laid the greatest number of eggs and yielded the highest returns from eggs sold over the cost of feed. The moist mash milk supplement did not justify the extra time and expense involved. The free-choice feeding of whole corn and oats to supplement the 22 or 32 per cent protein mashes was satisfactory.

This experiment definitely demonstrated that Leghorn layers in a high rate of egg production can properly balance their rations on the basis of protein by the free choice of whole corn and oats and a 22 per cent protein mash or a 32 per cent protein supplement mash.

As far as the poultryman is concerned, these experiments indicate that about equally satisfactory results can be expected from Leghorn layers fed either of the three types of rations and that either the all-in-one complete feed mixture or the free-choice feeding of whole corn, oats, and mash may be equally effective. There is no best ration and method of feeding for all alike. What may be best for one may not be suitable for another. Only the individual poultryman can decide which will best serve his particular preferences and requirements.

STATION HELPING TURKEY RAISERS

Ohio's turkey industry has grown rapidly in recent years and has become an important agricultural enterprise. The progressive turkey industry of today is largely a result of improved methods of management and a better understanding of the nutritional requirements of turkeys. To secure information and experience that would help the turkey growers of Ohio, the Station began work with 200 turkeys in 1938. In 1939, experiments were conducted with 400 turkeys.

A loss of 15 or 20 poults the first year resulted from digestive complications caused by the too-coarse ground oats in the starter. From this experience, it was learned that a better and safer procedure was to use no ground oats in the starter, but that after 6 weeks it was safe as well as desirable to keep whole oats in separate feeders before the turkeys at all times.

The poults were divided into groups of 200 to each brooder the second year. It was found, however, that for best results the number to one hover should not exceed 100, because the poults crowded and piled up outside the hover when frightened. For the same reason, it was learned that when turkeys are reared indoors the size of pen and number to each pen should be restricted.

After the first 9 weeks, the turkeys were subjected to three different management procedures: free range, confinement to colony houses and wire sun porches, and confinement indoors. One of the groups confined indoors was given cod-liver oil as its source of vitamin D; the other was exposed daily to ultraviolet light.

The rate of growth was practically the same for both range and confined groups. The loss of birds on range, including fighting, predatory losses, and missing birds, was 18 per cent as against 1 per cent of those confined. Although the feed consumption of the confined turkeys was somewhat greater than that of those on range, the greater loss of range birds more than discounted this advantage. Both years there was a minimum of losses from diseases or parasites.

The ration and method of feeding proved satisfactory both years, and they will be available to turkey growers who do not have a preferable ration and method of feeding.

DEFICIENT RATIONS DO NOT INFLUENCE HOG CHOLERA IMMUNIZATION

Failure to produce a firm immunity to hog cholera by serum virus treatment is claimed by some to occur when the treated pigs have been fed a ration deficient in minerals and vitamin D. Since the ration fed the pigs in some of the Station's earlier crystal-violet vaccine tests was somewhat deficient in minerals and vitamin D, it was thought desirable to ascertain whether or not rations deficient in these factors might affect the immunization of swine with crystal-violet vaccine.

Two groups of pigs were used in the test. One group received a ration deficient in minerals and vitamin D. The other received the same ration supplemented with minerals and vitamin D. Feeding of these rations was started 30 days before the pigs were treated with vaccine.

To test the immunity of these pigs, a portion from each group was exposed to hog cholera virus 30 days after vaccine administration; the remainder were exposed 104 days after vaccination.

Although marked evidence of nutritional deficiency developed in the pigs on the deficient ration, all were resistant to hog cholera exposure.

No appreciable difference in resistance was observed between the pigs of the two groups.

APPARENTLY WELL COWS MAY SHED MASTITIS GERMS

Findings by Experiment Station animal disease specialists indicate clearly that one or two negative tests do not ensure freedom from the germs of streptococcic mastitis in the milk of an infected animal that has apparently recovered from the disease.

Studies were made to determine the constancy with which streptococcic mastitis germs are shed in the milk of infected cows, and it was found that

there is no regularity in the occurrence of the germs in drawn milk. The organisms may appear in milk for days and weeks, then suddenly fail to show up, only to reappear in later samples.

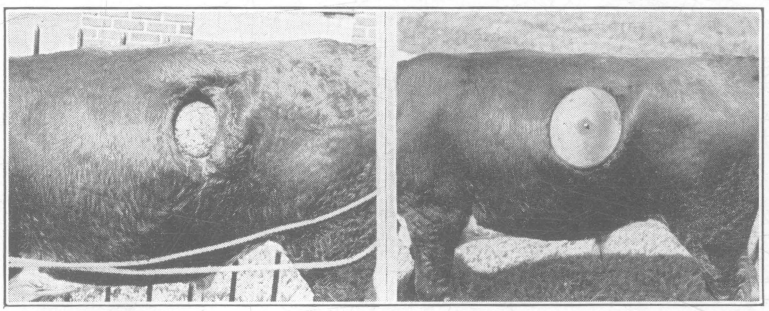
CONTROLS FOR SHEEP PARASITES RATED

Either tetrachloroethylene or a combination copper sulfate – nicotine sulfate solution gives the best control of gastrointestinal parasites of sheep, according to Experiment Station specialists who have been seeking a control for these parasites, which cause serious losses to sheep growers.

During the past 3 years, the tetrachloroethylene and the copper sulfate – nicotine sulfate solution have been tested for their anthelmintic value, along with several other preparations. These anthelmintics were administered to various groups of lambs at 3-week intervals during the pasture season. The lambs were then slaughtered, and the abomasum and intestines were collected and examined for the presence of parasites. Untreated lambs kept with the treated lambs were also examined for parasites as a check.

WINDOWS IN STEERS AID DIGESTION STUDIES

Considerable speculation has been made as to what happens to the whole kernels of corn that pass the omasum, or third stomach, in cattle in their passage through the remainder of the intestinal tract. Now, with the aid of windows in the sides of steers, workers have been able to see that practically no sound, whole kernels of corn are broken down after they have passed the third stomach of feeder steers. Of all the kernels that get through the third stomach whole, 97.4 per cent pass out in the feces intact.



Windows in steers help show what happens during digestion.

Left—Steer with window open Right—Rubber plug in place to retain stomach contents

HOME ECONOMICS

DETERMINING FOOD NEEDS OF YOUNG ADULTS

Since 1936, workers connected with a number of agricultural experiment stations in the North Central States have been studying the food needs of young adults, using college women as subjects. Surveys of the foods used by these young women have shown trends in food consumption and have indicated the extent to which the protective foods form a part of the diet of college women, and, hence, the extent to which the newer knowledge of nutrition is being applied.

The relationship of the amounts of nutrients excreted to the amounts in the food eaten is of significance in determining the amounts of various nutrients most desirable. During the period from 1936 to 1939 this problem has been studied in Iowa, Kansas, Nebraska, and Ohio as part of the cooperative project. Records have been kept for a group of almost a hundred young women who were eating their customary or freely chosen diets. Wide variations have been found in intakes as well as in amounts excreted. Such wide variations pointed to the need for more detailed study to determine, if possible, some of the factors influencing the retention of the nutrients.

Among the factors which have been suggested as influencing retention are the amounts of various nutrients in food eaten, individual differences in digestion and utilization of foods, the influence of ascorbic acid on the utilization of calcium, the relation of the amount of calcium to the amount of phosphorus in the diet, the acidity of gastric contents, and the degree of repletion or depletion of body stores of the nutrients.

In order to make a more detailed study of the causes of the individual differences, plans for the balance studies have been revised. In Ohio, four young women for whom balance studies on their freely chosen diets have been made in preceding years are to be used as subjects during 1939-1940 to study the causes of individual differences in the extent to which the nutrients in food are retained.

The four young women acting as subjects in Ohio are to be given similar weighed amounts of such foods as meat, eggs, fruit, vegetables, and whole grain cereal products. In addition to this foundation diet, such foods as butter, salad dressing, jelly, cookies, and apples are to be used in weighed amounts as desired by the individual subjects. Milk is to be added to the daily diet in varying amounts to determine the effects of such variation on the calcium intake as well as on the calcium retention. At each level of intake, a preliminary period of 15 days is to precede a collection period of 10 days. In one series of tests, the effect of the addition of 250, 500, and 750 cubic centimeters of milk daily is to be studied. In another, the possible influence of the daily intake of approximately 400 international units of vitamin D on the retentions at the three levels of milk intake is to be studied.

It is expected that the results will throw some light on the reasons for differences in retentions of calcium, phosphorus, and nitrogen in young women on their freely chosen diets.

GLASS CURTAIN FABRICS STUDIED

The comparative study of fabrics used as glass curtains undertaken in 1937 has been continued. As the selection of such fabrics is a difficult problem for the consumer-buyer, and one on which almost no research has been done, it is hoped that the present study will furnish information of practical value.

Since glass curtains are usually exposed to sunlight for a considerable part of the time, and since they are usually subjected to repeated laundering, it is desirable to know which fabrics best withstand the effects of light and laundering. One part of the present study, therefore, is concerned with the effect of light on the strength and color of glass curtain fabrics. For this purpose, one set of samples of the fabrics was exposed to sunlight in outdoor fading frames for 100 hours; another set was exposed to light in a north window; and a third set is being exposed to light in a Fade-Ometer. All these samples are to be tested for color fastness and for the effect of light on breaking strength. Comparisons will be made of the effect of direct sunlight, light in a north window, and exposure in the Fade-Ometer.

A second major concern is the study of the effect of 10, 20, and 30 launderings on strength, color, and shrinkage of the fabrics. One set of samples will be ironed with a hand iron, and another will be stretched. Preliminary tests have been made to formulate laundering methods, and samples have been prepared for laundering tests.

Chemical and physical properties of the original fabrics are being determined so that the relationship of these properties to the effect of light and laundering may be studied. During the past year, the weight in ounces per square yard of 30 of the fabrics was determined. As a portion of the determination of kind and amount of finishing materials, all the fabrics were ashed, and the ash was subjected to spectrographic analysis. Samples also were prepared for yarn size determinations. Results of these experiments will eventually be correlated with the information on the effects of light and laundering.

RURAL ECONOMICS

METHODS OF RENTING FARM LAND VARY WIDELY IN OHIO

About 39 per cent of all Ohio's farm land is tilled by tenants, and in some counties, the figure goes higher than 60 per cent. About four-fifths of these tenant farmers pay their rent with shares of the crops or livestock they raise; about one-fifth operate under a cash rent agreement. Although the proportion varies widely between counties, about the same number pay their rent in livestock as in crops. There is, however, some trend toward the livestock share system of renting.

Within both systems of share renting there is a wide variation in division of sales. On about two-thirds of the crop-share farms the owner receives one-half the crops; frequently the owner receives two-thirds when the tenant furnishes only the labor. On some of these farms the owner receives a cash rent for pasture in addition to his share of the crops. On the majority of the livestock-share farms, the owner receives one-half of all sales as rent, but here again a few owners receive two-thirds.

There seems to be an even wider variation in the sharing of expenses than in the sharing of receipts.

LEGAL ASPECTS OF LANDLORD-TENANT RELATIONSHIPS UNDER STUDY

Because so many Ohio farmers till rented land, present systems of farm tenancy are affecting Ohio's agricultural future. The property rights created by renting agreements influence the management of the land, the welfare of both landowner and tenant, as well as the whole social pattern of community life. Agreements between landowner and renter which are now customs may become solidified in laws. Such laws might or might not best serve the future. Good farm management practices might be encouraged by changing existing laws, but such questions cannot be answered until the social and economic effects of existing laws are determined.

With this idea in mind, economists of the Ohio Agricultural Experiment Station have made during the past year, a study of the legal aspects of landlord-tenant relationships in Ohio. They confined their efforts in this initial study to gathering together the facts in the statutory law and court decisions that affected landlord-tenant relationships. Their work is summarized in the following points:

1. Landlord-tenant relationships have their legal foundation in the common law of England existing at the time the American Colonies achieved their independence. Legislation in various states has superseded the common-law rules on certain points. On all points the interpretation given by the courts in each state has established precedents which may or may not hold in other states.

2. The Ohio Constitution is silent in respect to landlord and tenant, but it does empower the Legislature to pass laws which are relevant, and the courts are empowered to render decisions which establish precedents influencing the rights and duties of landlords and tenants.

3. Very little legislation in Ohio concerns farm tenancies in particular; the usual application is to tenancies in general.

4. To comply strictly with the statutory law, a lease of land must be in writing. This provision is a part of the statute of frauds.

5. The statute of frauds also specifies that contracts which cannot be performed within 1 year from the making must be in writing.

6. The law specifies that temporary leases (for not more than 3 years) need not be attested, acknowledged, or recorded.

7. Leases for more than 3 years should be attested and acknowledged, and should be recorded to assure absolute protection against a purchaser or new lessee without notice of the existing lease.

8. Through the precedent of court decisions, part performance cures the defect of an oral lease covering a term of not more than 3 years. In most circumstances an oral lease for more than 3 years is held to be null and void, but the occupancy serves to create a tenancy from year to year.

9. Only 3 days' notice before beginning action to eject a tenant is required to dispossess a tenant holding over his term, or when possession is under an oral tenancy and payment of rent is in default, or when possession is held without color of title.

10. The common law permitted a landlord to distrain property to secure the payment of defaulted rent. Ohio law does not permit such distraint. In a share crop tenancy the lessor and lessee are joint owners in the crop and the landlord holds title to his share from the beginning. Past-due cash rent may be collected through obtaining judgment as for any debt.

11. A tenant dispossessed for reasons beyond his control is entitled to emblements such as re-entry to harvest an away-going crop. This right is given by the law to protect the legal interests of a tenant and thereby prevent the hardship which might result from the short period of legal notice which the Ohio law specifies.

12. The statutory law of Ohio is silent about waste by a tenant for years or shorter periods. The courts of Ohio never have held strictly to the common-law rules of waste although obvious and flagrant acts of waste are discouraged.

13. The statutory law of Ohio makes no provision for the removal of fixtures supplied by a tenant or for compensation for improvements. In the absence of specific agreement to permit removal, fixtures other than trade fixtures become a part of the land and cannot be removed.

14. Leasing agreements do not create master-servant or principal-agent relationships, but a cropper has been held by courts in some states to be a servant for whose acts a landowner would be held accountable. A few court decisions in other states have held a cropper to be an independent contractor for whose acts a landowner would not be held accountable. No Ohio decisions completely clarify the status of croppers.

15. A leasing agreement does not, under ordinary circumstances, create a partnership. Even a livestock share lease is not a partnership unless the lessor

and lessee intend it to be so. On the other hand, if a business is conducted so as to lead strangers to believe it to be a partnership, the responsibilities of a partnership would rest on the lessor and lessee when dealing with strangers.

A number of these points seem to justify study with possible modification in view. For instance, should the requirement that a lease be in writing be given a wider and more definite application? It is a matter of common knowledge that a great many agricultural leases rest entirely on oral agreement, which makes misunderstandings easy. The law in no way encourages the tenant to make improvements, because no compensation is allowed for increasing the productivity of the soil, for installing fixtures, or for making building improvements. On the other hand, no penalty is incurred for practices causing waste and deterioration. Farm tenants are poorly protected by the Ohio law on giving notice to vacate. The old common-law rule of 6 months' notice was more practical for agricultural tenants than the present rule.

OHIO'S FARM INCOME FAIRLY STABLE

As the State's agricultural industry is a diversified one, Ohio farmers receive their income from a wide variety of sources. Because of this diversification, the income of the industry as a whole stays about the same from month to month, although receipts from wheat and some of the specialized crops are seasonal. Largest total income is received in July and October. January and February are the low months.

Percentage of annual income received by Ohio farmers each month*

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Hogs	8	7	9	9	8	8	7	7	9	10	9	9	100
Cattle and calves	8	8	9	9	9	9	8	8	8	8	8	8	100
Sheep and wool	7	5	6	13	15	13	7	8	7	6	6	7	100
Poultry and eggs	6	6	7	9	9	9	8	7	8	8	12	11	100
Dairy products	8	7	8	8	8	9	10	9	9	8	8	8	100
Wheat	6	6	6	5	4	4	25	14	10	8	6	6	100
Corn	11	9	9	8	7	7	7	8	8	6	9	11	100
Oats	7	7	7	7	6	5	8	20	12	7	7	7	100
Soybeans	13	5	5	6	9	.....	.....	.....	.....	24	20	18	100
Hay	10	8	8	8	6	7	7	6	9	10	11	10	100
Tobacco	20	34	27	10	5	.....	.....	.....	.....	.....	.....	4	100
Potatoes	4	5	5	1	1	1	2	16	23	24	14	4	100
Truck crops	3	4	4	7	8	12	14	13	13	10	7	5	100
Apples	6	4	5	3	2	2	5	3	8	28	22	12	100
Total, all products	7	7	8	8	8	8	9½	9	9	9½	9	8	100

*Figures cover the years 1936, 1937, and 1938.

SHORT LIVESTOCK HAULS COST MORE THAN LONG

There seems to be little relation between the average motor truck rate charged and the distance that hogs are hauled to the Cleveland livestock market. In fact, in 1939, farmers living close to Cleveland actually paid more for hauling than those living farther away. During 1939 the average rate per hundredweight for a distance 30 to 40 miles from Cleveland was 32.1 cents, for a distance 130 to 140 miles from Cleveland, 29.6 cents.

Railroad rates to the Cleveland market are lower for any given distance than truck rates. Railroad rates increase as distance increases.

Average rate for transporting hogs to Cleveland, by mile zones, 1937, 1938, and 1939

Dollars per hundred

Mile zones	Motor truck			Railroad	
	1937	1938	1939	Double deck	Single deck
0- 9	0.30		0.40		
10- 19	.08		.37		
20- 29	.30		.32	0.13	0.15
30- 39	.35	0.37	.32	.14	.16
40- 49	.35	.32	.31	.15	.17
50- 59	.34	.32	.33	.16	.18
60- 69	.34	.31	.32	.17	.19
70- 79	.33	.33	.34	.17	.20
80- 89	.33	.32	.32	.18	.21
90- 99	.34	.33	.30		
100-109	.29	.31	.27	.20	.23
110-119	.28	.28	.26	.20	.23
120-129	.29	.28	.27	.21	.24
130-139	.31	.31	.30	.21	.24
140-149	.30	.40	.33	.22	.25
150-159	.31	.37		.22	.25
160-169	.55	.25		.22	.25
170-179	.40			.23	.27
180-189	.29		.11		

If such a system of trucking rates continues, what are the probable consequences? One likely change will be the shifting of areas from which markets draw their livestock. Factors other than motor transportation rates will influence the farmer to market at a certain point. Particularly will this be true of the farmer on the outer edge of two marketing areas.

Another question is, if such a system of rates continues, will motor transportation rates continue to be set by the individual trucker as at present, or will more regulation be placed on the transportation system? It would seem at this time that the livestock marketing system of the future may be influenced considerably by the future rate system evolved for trucking livestock.

CLASSIFYING DAIRY FARMS BY MARKET OUTLET

A project that will classify dairy farms into market outlets for city milk supply, evaporating plants, butter and cheese factories was started in April of 1939. A survey is being conducted with natural marketing areas as units. The first area to be studied comprises Franklin, Madison, Union, Delaware, Licking, Fairfield, and Pickaway Counties.

Lists of farms producing milk are obtained from the records of cattle testing for tuberculosis on file in the office of the State Veterinarian and are assembled by townships. When township lists are completed, the information as to the market outlets is obtained from key men in each township.

This project will supplement and bring up to date the study of sources of market milk and butterfat supplies in Ohio. It is a phase of the larger prob-

lem of the elasticity of supply. Several previous studies have been made of receipts in markets of various types. This study is the first attempt to analyze the supply in a comprehensive way from the individual farm approach.

It has already been found that of 10,364 milk producers from seven counties in the Columbus milk shed, 39 per cent sell sour cream, 32 per cent sell to milk distributors, 27 per cent sell to manufacturing plants, and 2 per cent distribute their own milk.

RETAIL PRICES A POOR GUIDE TO QUALITY

People who believe that high prices guarantee high quality in fresh and canned retailed fruits and vegetables are apt to be disappointed.

Experiment Station economists purchased representative samples of these goods in typical retail grocery stores, determined their quality, and found that in the main, quality and retail price were not related.

These same economists conducted a survey among the customers of a large chain grocery store in a neighborhood shopping district of Columbus, Ohio, to see what these people thought of a 3-month program of educational advertising and displays featuring canned foods labeled according to grade, or quality. Customers responded to such advertising and thought grades reliable guides to the quality of goods purchased.

As a result of these studies, the economists recommend a program of standardization and grade identification that will classify fresh and canned fruits and vegetables into grades based on consumers' preferences and gradations of buying power and that will require a grade name or symbol on the goods until they are purchased. Such a program would result in immediate gains to consumers. It would help them to get their money's worth when they buy. It would also soon result in gains to producers and distributors. A closer relationship of price to quality would result in the payment of premiums in the form of higher prices for high quality.

EGG AND POULTRY COOPERATIVES AID GRADING WORK

In cooperation with the Farm Credit Administration, a survey has been made of cooperative egg and poultry marketing in Ohio. This survey revealed that there are at present five principal types of egg and poultry handling by Ohio cooperatives. There are organizations which handle eggs or poultry as a side line and which for the most part handle these products only as an accommodation to their patrons; organizations in which eggs are not the major item but in which the operations are large enough to make the association an important cog in the poultry and egg marketing machinery of the community; direct sales poultry associations; poultry and egg auctions; and poultry shipping associations conducted by cooperatives.

The most significant contribution made to marketing by Ohio egg and poultry cooperatives has been in the field of grading and inspection, and the most effective work in this field is done under a Federal-State supervised program. As a result of the cooperation of these associations with the Ohio Federal-State Egg Grading Service, original purchasers were able to buy over 142,000 cases of graded eggs in Ohio in 1938 from these organizations.

AGRICULTURAL ENGINEERING

STUDYING STORAGE OF EAR CORN

Many of the structural problems of corn storages are related to proper curing of the corn. There is evidence that the construction and maintenance of safe, durable corn cribs are far greater problems than most people realize. Agricultural engineers of the Experiment Station, in cooperation with the Bureau of Agricultural Engineering of the United States Department of Agriculture, are studying in a specially designed corn crib the pressures and forces of stored ear corn.

Such studies show that within a few days' time the outward pressures on the sides of a corn crib may fluctuate rapidly, sometimes to the extent of doubling the pressure. Another interesting action noted was that the upward push of corn on the sidewalls tends to lift the walls from the floor. This action is most likely to occur when very dry corn takes on moisture rapidly.

The present work includes measurement of moisture content changes in the corn in relation to weather variations. Results show that corn usually loses moisture most rapidly in the late afternoon and early evening, often gaining back moisture in the forenoon.

Ear corn sometimes heats and goes out of condition in the spring of the year when the corn is apparently well cured and dry enough for safe storage. This type of heating is apparently caused by absorption of moisture during damp weather. In order to prevent spoilage of corn that is to be stored through late spring into the summer, it seems best to shell corn when the moisture is below 14 per cent and then store it in a tight bin where weather will not affect it so readily. If ear corn must be stored, then as soon as the corn is dried down to below 14 per cent moisture, the sides of a crib should be sealed to prevent ventilation. Ample ventilation is essential to prevent the growth of mold in green corn; therefore, no attempt should be made to restrict ventilation until the corn is dried below 14 per cent.

BARN CURING PARTLY DRIED HAY NOW POSSIBLE

Four hours from mowing the grass to storing the hay in the mow is a reality. Partly cured alfalfa hay was chopped and placed in a mow for additional drying with forced natural air on the Harold Anderson farm at Maumee, Ohio, in 1939. This method was a modification of a similar method tested during the past few years by the University of Tennessee Agricultural Experiment Station and the Tennessee Valley Authority cooperating.

The agricultural engineers made observations and measurements on the Anderson farm during the cutting, mowing, and curing of the second and third cuttings of alfalfa. The results with chopped partly cured hay were about the same as with the long hay used in the Tennessee experiments. The hay will lose about three-fourths of the necessary moisture reduction in about 4 hours of good field drying. The moisture content should be less than 45 per cent when the hay is placed in the mow. The excess moisture can be successfully dried in

the haymow in about 2 weeks' time by the use of natural air forced through the hay. A pressure fan and suitable air flues are necessary but do not constitute very expensive items. If future studies substantiate the past findings, most of the present weather hazards of haymaking are eliminated. The cost of the method is within the means of almost every farmer. It should also be possible to adapt this method to most types of barns and sizes of crops found on Ohio farms. This method of haymaking eliminates nearly all losses of leaves and retains the vitamin substances in much larger amounts than field-cured hay. Where the alfalfa crop is cut in the morning and placed in the mow in the afternoon, there is very little chance of losses due to rain.

DISTRICT AND COUNTY EXPERIMENT FARMS

TILE DRAINAGE NOT HIGHLY PROFITABLE ON SOME SOILS

For 26 years, an experiment has been carried on at the Clermont County Experiment Farm to determine the value of tile drainage on this soil, which is rather evenly divided between Rossmoyne and Clermont silt loam. The rather small crop increases in general from tile drainage indicate that on this soil, an elaborate and costly system of tiling is not profitable, that a system of draining only the wet spots with tile is more economical.

MANURE AND FERTILIZER INCREASE POTATO YIELDS

At the Hamilton County Experiment Farm, 16 tons of manure and 750 pounds of 6-8-6 have been of about the same effectiveness on early potatoes during the past 3 years. Each has increased yields approximately 90 bushels per acre when applied alone. When both were applied on the same plots, the increase was just about double this figure. Continuous culture with barley cover crops has been less effective than rotation on this soil, which is too heavy for best potato yields. In general, a 3-year rotation has been superior to one of 2 years. Unless clipped in the spring, wheat after heavily fertilized early potatoes is likely to grow so rank that it smothers the young clover. It has been feasible to eliminate the small grain crop and sow an alfalfa-timothy mixture after potato harvest. This mixture provides a year or two of hay, but the potato yields have not been as large after it as where a legume crop was plowed down and followed by other crops which in turn were plowed down for potatoes. In this southern part of Ohio, vetch and crimson clover sown after potato harvest have provided a large amount of material for plowing down the following year.

WILL SUNFLOWERS ELIMINATE WIREWORMS?

Potato growing is a hazardous business in many areas of northeastern Ohio because of the wireworm. That wireworm is a hard pest to control is indicated by work at the Mahoning County Experiment Farm, where the past 5 years have been devoted to a study of potato rotations as a means of control. Under continuous culture with a winter cover crop of rye and spring plowing as early as May 1, there was a larger wireworm injury in 1939 than there had been 5 years earlier. The same result occurred in many of the 2-year rotations, which included sweet clover, Sudan grass, and corn as the crops grown during the year without potatoes. Mustard apparently did not have a high degree of efficiency. The most promising lead was sunflowers. This crop was readily grown, controlled weeds during its season of growth, and was rather easily disked down in time for sowing rye for winter cover. Whether the lower wireworm count was due to the sunflowers or to the plot location in the series was not clearly answered. The work is being continued, and sunflowers will be grown on those plots now known to have a high wireworm population.

CAN ENSILE CORN AT DIFFERENT STAGES OF MATURITY

Farmers know that corn silage is a good roughage for steers, but limited labor and power available at one time often keep them from ensiling a large tonnage when all the corn has to be put into the silo within a rather short time to catch it at the right stage of maturity. In order to see whether corn could not be ensiled at different times, silage made from very immature corn and silage made from corn at what is considered the proper stage have been compared in feeding value for steers. During the past 10 years, the number of pounds of silage required to produce 100 pounds of beef has not varied much between the two, even though the silages have carried very different amounts of corn as grain.

CROSSBRED HOGS EXCEL

The work in crossbreeding hogs at the Miami County Experiment Farm has progressed to the point where females containing the blood of three breeds are being used for brood sows. One-half of the herd at this Farm still is composed of purebred Durocs; the other half are descendants of the original purebreds but now carry some inheritance from purebred Poland and Hampshire boars that have been used since the work started. Results thus far have been consistently in favor of the three-breed cross, although the purebred Durocs have made a very creditable record.

PROFITABLE DAIRYING IN NORTHEASTERN OHIO POSSIBLE

Work at the Trumbull County Experiment Farm continued to chart a more profitable system of dairying for northeastern Ohio. This system is built around a maximum use of good roughage from high-quality pastures, hay, and silage and a minimum use of grain.

During the past year, yields of 9,610 pounds per acre of hay from first-year clover-alfalfa-timothy meadows and 8,580 pounds from second-year alfalfa-timothy meadows were obtained. Such yields indicate that with adequate liming, this region can be made a great grass section of Ohio.

With one-half of the tillable area in meadows, enough hay was provided for winter feeding, also sufficient rotation pasture to supplement the permanent bluegrass pastures during the period when they were naturally dry and brown. Consequently, feeding from the mow or silo during the summer was unnecessary, and labor was conserved.

The Holstein herd, with several first-calf heifers, fed under this system produced an average of 11,600 pounds of milk and 386 pounds of butterfat during the year. This is good commercial production and was produced under conditions favorable to economy of labor, utilization of cheap roughage, and conservation of soil fertility.

PAULDING COUNTY SOILS NEED ORGANIC MATTER

At the Paulding County Experiment Farm, corn borer counts made by the Station's Entomology Department showed such a striking correlation with corn yields that it is thought the fertility level of a soil may be indicated by its relative corn borer infestation. Because corn borers like rapidly growing corn, the

highest infestation (88 per cent) occurred in corn that yielded around 100 bushels per acre and the lowest (33 per cent), in corn that yielded 50 bushels. The average of all commercial fields examined in the county was approximately 30 per cent, which is taken to mean that the average corn field in the county is the product of a soil-management system that throughout the past 25 years has permitted its crop-producing power to sink to a rather mediocre level. Past and present experiments at the Paulding County Experiment Farm support this idea. Ever since this farm was started in 1911, soil problems have been studied.

The first surprise on this farm came when several years' work failed to show any appreciable results from the use of commercial fertilizers. In 1918, however, an experiment was started in which two plots were rotated in corn and oats without any clover. These plots rapidly decreased in yield, and in 1939 produced only 21 bushels of corn and 36 bushels of oats per acre. In 1936 a more comprehensive series of plots was started on uniformly good soil. This series varied from continuous corn to rotations which contained alfalfa for 2 years out of 4. Corn yields in 1939, the fourth year of the test, varied from 108 bushels per acre down to 43 bushels. The high yield occurred in a 3-year rotation of corn, oats, and sweet clover in which corn stover, oat straw, and the entire sweet clover crop were returned to the soil. The low yield was in a 2-year rotation of corn and oats, without any clover and with the corn stalks and oat straw removed. Since this test was started on fairly good soil, these yield differences probably are due more to a rapid decrease caused by the poor rotation rather than to any great increase by the good one. The results indicate a vital need for maintaining in these soils a suitable supply of organic matter.

TIMOTHY MEADOWS BETTER ON FERTILE SOIL

Tests at the Washington County Experiment Farm show that the fertility of the soil rather than the time of cutting is what determines the timothy stand after a period of 2 or 3 years. On all plots where no manure or commercial nitrogen was applied, the stand was exceedingly thin regardless of the time of cutting. On those plots which received an annual treatment with a nitrogen-bearing fertilizer, the stand was good. With proper fertility treatment, timothy meadows in southern Ohio may be cut early enough to make high-quality hay and still last a reasonable number of years.

ROTATING SHEEP AND CATTLE ON PASTURE AIDS IN PARASITE CONTROL

Parasites are making it more and more difficult for sheep growers in large sections of southeastern Ohio to make a profit. Very timely, therefore, is the work being done at the Southeastern Experiment Farm on parasite control. The present control system has sheep on any one pasture only during alternate summers. In between, the grass is consumed by cattle. Thus, two winters and one summer intervene before sheep are permitted back on pastures formerly grazed by them. This lapse of time appears to be quite efficient against some parasites, such as hookworm and nodular worm. It is not so efficient against stomach worm, but this parasite is rather easily controlled by ewe and lamb treatments.

The system was started by replacing the old parasite-infested flock with so-called clean ewes raised from birth in a manner which safeguarded them as far as possible against infection with the several gastrointestinal species of parasites. The first crop of lambs, which are now large, well-grown, healthy 4-year-old ewes have never had a single anthelmintic treatment during their lifetime. In practice, however, it probably will be desirable to use some such treatment along with annual pasture rotation rather than to rely on rotation alone for complete protection. From several sources has come information indicating that better utilization of pasture is obtained by having cattle in addition to sheep on a given farm. The later discovery concerning parasite control is further evidence of the wisdom of having two types of livestock rather than sheep alone to utilize the pasture on many farms.

HIGH TOBACCO YIELDS NOT HARD TO PRODUCE

Tobacco growers are inclined to long for "new" soil on which to grow tobacco, but they can secure good results by proper treatment of soils which have been cropped for many years.

A top yield of 1,805 pounds of tobacco of the Spanish-type was secured at the Southwestern Experiment Farm in 1939. Yields that large have been rare at this Farm in the 36 years of its existence, but from start to finish, there was nothing about the system which produced this one that could not easily be adopted by the average tobacco grower. The rotation was the simple one of tobacco, wheat, clover which has been followed on that land for over 30 years. Ten tons per acre of shed manure were applied on the clover sod. At setting time, 800 pounds of a 2-14-4 fertilizer were drilled per acre, and when the tobacco plants were nicely started, 100 pounds of nitrate of soda were applied as a side-dressing through a fertilizer attachment on the cultivator. Previous experiments had shown that each of these practices was good; so 3 years ago all were combined on a single plot. The results have been excellent each year since then.

FORESTS AND RECREATION

PUBLIC INTEREST IN FORESTRY INCREASING

Significant events which reflect the public's interest in forestry problems occurred during the session of the State Legislature which convened January 2, 1939.

The forest tax law amendment, designed to simplify the Act and increase its effectiveness was received in both the House and Senate in a manner indicating consciousness of a need for favorable forestry legislation.

A companion bill was passed which authorizes county auditors to deed to the State any land forfeited through tax delinquency that fails to sell at a regular March sale of forfeited lands.

The first law will improve the management and care of classified forests; the second will make useful State forests of lands which have been abandoned by the owners.

The provision was written into the appropriation bill whereby the State will pay to the county treasurer of each county containing a State forest, 25 per cent of all funds received by the State from the sale of the forest's products.

Disbursements under this law for the first 6 months of the calendar year 1939 were:

Hocking County	$ 51.67
Ashland County	317.23
Ross County	32.36
Scioto County	13.12
Athens County	15.00
Vinton County	17.92

TWO MILLION ACRES PROTECTED FROM FOREST FIRES

Because of planting or natural seeding of abandoned fields, the woodland areas and abandoned farm areas within the region protected from forest fires by the Ohio Division of Forestry have increased to the extent that the Division is now protecting over 1,200,000 acres of woodland and over 800,000 acres of abandoned and unplowable pasture land, a total of 2,000,000 acres.

Comparison of number of fires and acreage burned during the past 2 fiscal years

Fiscal year	Number of fires	Acres of woodland burned	Average acres of woodland burned per fire
1937, fall	81	511.7	6.32
1938, spring	288	1,382.4	4.80
Total	369	1,894.1	5.13
1938, fall	140	808.5	5.85
1939, spring	377	1,869.6	4.96
Total	517	2,678.1	5.18

The total acreage burned and the average size of forest fires for the fiscal year 1938-1939 were very low considering the long duration of the fire seasons, high winds, low visibility, and long periods of drouth.

The number of fires, as well as the acreage burned, increased over the fiscal year 1937-1938, but the acreage of woodland burned per fire was held to the same low average.

Only 0.225 acre of woodland in every hundred acres protected suffered any damage from forest fires during the past year. Protection for the 1,200,000 of woodland plus 800,000 acres of abandoned farm land was accomplished at a cost of less than 1½ cents per acre for the area protected.

During the spring of 1939, over 9,000 burning permits were issued by the fire wardens. This was an increase of nearly 50 per cent over the spring of 1938. Less than 1 per cent of the burnings by permit got out of control, and most of these escaped from inexperienced brush or debris burners. This care alone shows the remarkable interest taken in fire control by landowners and their tenants.

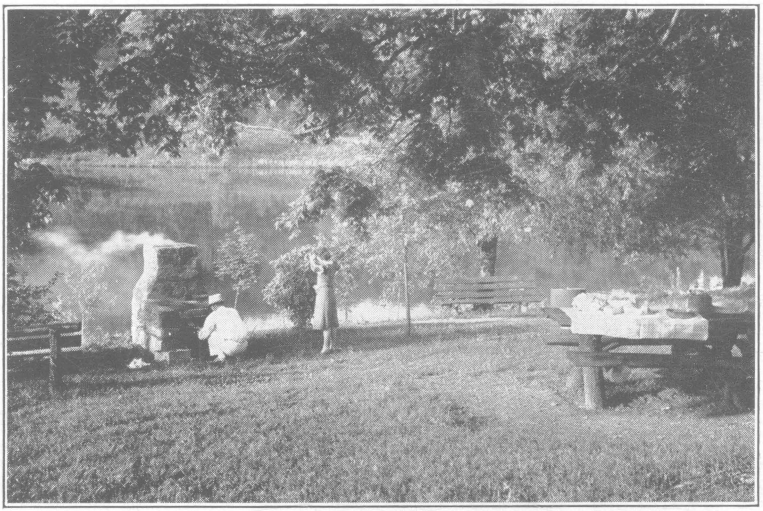
Nineteen fire towers were manned during the fire danger periods of the year. As a whole, the towermen and fire wardens, with their registered crews and helpers, did splendid work, but there remains room for improvement. In order that fire wardens may be familiar with fire-fighting technique, training schools should be held for teaching the general principles of fire control and prevention. Such fire schools will be held as soon as the necessary funds are available.

STATE FORESTS AND FOREST PARKS EXPANDING

LAND UTILIZATION PROJECTS

Commencing in 1935, the Ohio Division of Forestry encouraged and sponsored the acquisition by the Federal Resettlement Administration, of three large areas of submarginal land in southeastern Ohio. Each of these areas was marked by a general deterioration of timber, soil, and living conditions resulting from the more or less unconscious misuse of the land and timber at the hand of the resident owners and other occupants of the areas. The Resettlement Administration not only purchased large blocks of this kind of land, but immediately embarked upon a program of development, drawing upon the Works Progress Administration and the Public Works Administration for needed labor. The plan of development was a multiple-use program which included forest planting, timber stand improvement, wild life and game management, and public recreation. Fields long eroded and impoverished but capable of supporting tree growth were reforested. Truck trails, bridges, and telephone lines were constructed, and provisions were made for picnicking and other recreational uses. In each tract, the main public use area was laid out near an artificial lake.

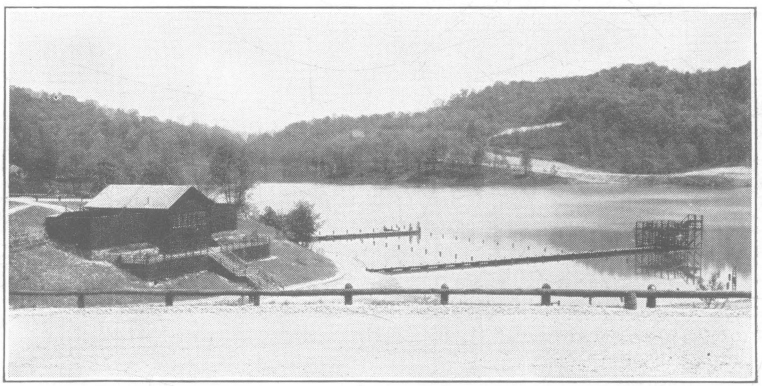
In Tar Hollow, on the northeast side of the 16,000-acre Ross-Hocking Project, an earth dam was constructed to impound 16 acres of water. On this attractive lake, the Tar Hollow Group Camp was operated by the Ohio Division of Forestry during the summers of 1938 and 1939. Organized groups leasing the Camp included Girl Scouts, Boy Scouts, religious groups, 4-H Clubs, the YMCA, and the Agricultural Extension Service. The normal capacity of the



Picnic grounds on the lake

camp is 175 persons, including the counselors, cooks, and administrative staff which must be provided by each renting group. During the summer of 1939, the rental rate for the camp and all facilities was $25 per day.

Equipment of the camp includes 28 sleeping cabins, arranged in four groups of seven cabins each, with an eighth building in each group which provides showers, lavatories, and toilet facilities; a beautiful dining hall complete with an ample kitchen and food storage; cook's quarters; infirmary; and central shower house. Far back up the hollow in the woods is an outdoor theater. Commercial electric power to supersede the present power plant was anticipated at the close of the 1939 season.



Fully equipped swimming pool and bathhouse

HUNTING AND GAME REFUGES

The Division of Conservation and Natural Resources has cooperated in the selection and marking of suitable areas within the State Forests as game refuges. Picnic and scenic areas must be closed to shooting because of the danger to the thousands of visitors, but the value of such areas as game refuges is considerable for grouse and small fur-bearing animals. Although hunting is prohibited on 10,000 acres of State Forest land, regulated hunting is permitted on more than 50,000.

Game refuges on State Forests

State Forest	Forest closed	Game refuges within forest	Portion open to hunting	Total forest area
Bryan Park	636			636
Dean Forest			1,795	1,795
Findley Forest	365			365
Hocking Forest	4,597			4,597
Mohican Forest	2,102			2,102
Nelson Ledges Park	45			45
Pike Forest			4,747	5,257
Tobacco Barn		180		
Anderson-Waldron		330		
Scioto Trail Forest			8,496	9,438
Coon Hollow		412		
Long Branch		530		
Shawnee Forest			35,661	36,481
Spencer Run (birds)		50		
Pheasant Hollow		255		
Gordon		200		
Big Run		315		
Waterloo Forest	447			447
Zaleski Forest			3,393	3,393
Total	8,192	2,272	54,092	64,556

Good fishing will soon be available in nine different lakes where water has been impounded by State Forest CCC Camps or by the WPA labor on resettlement areas that are to come under the supervision of the Division of Forestry.

RECREATION

As a means of gauging public interest in park and public use areas in the State Forests, and to provide a basis for appraising public use administrative requirements and the adequacy of park facilities, it has been customary for the Division of Forestry to take a census of visitors during the month of August. During August 1939, 121,452 people visited the State Parks. Attendance far beyond the capacity of public use facilities is being experienced at several points.

TREES PRODUCED IN STATE NURSERIES

Species and numbers of trees produced in State nurseries in 1939

Coniferous species	Number of trees	Hardwood species	Number of trees
Red pine	1,707,895	Black locust	1,034,250
White pine	1,296,955	Tulip poplar	229,220
Shortleaf pine	979,475	Sugar maple	174,180
Norway spruce	405,225	White ash	107,600
Scotch pine	232,250	Red oak	85,748
Hemlock	87,575	Black Walnut	84,172
European larch	44,325	Beech	36,055
Austrian pine	38,300	Catalpa	12,515
Pitch pine	22,678	Osage orange	9,350
Corsican pine	3,300	Cottonwood	9,010
		Black ash	6,650
		Swamp white oak	5,600
		White oak	4,600
		Red maple	3,400
		Dogwood	1,700
		Red gum	500
		Miscellaneous	2,801
Total	4,817,978	Total	1,807,351

STATE FORESTS ENLARGED

Little progress has been made during the year toward the acquisition of land for State forests. Much adjoining land, however, is for sale at prices ranging from $3.00 to $10.00 per acre. The need for further acquisition is most urgent in some of the forest parks where the attractiveness of roads, trails, and vistas is often dependent upon forests that are still held in private ownership.

Additions to State Forests during the year 1939

Forest	Grantor	Acreage	Price per acre
Pike	Charles Vallery	60.03	$5.00
Shawnee	A. J. Odle	40.72	5.00
Dean	Manda Evans	101.10	6.92
John Bryan	Hugh Taylor Birch	20.62	Gift

SURVEY OF OHIO FOREST RESOURCES STARTED

During the past year, the Ohio Division of Forestry has been conducting an intensive State-wide survey of Ohio's forest resources. This survey, a WPA project, includes field surveys in all counties of the State. The project consists of three phases, a woodland survey, a survey of forest plantations, and white pine blister rust control. Recent approval has been received for a superseding project which will carry the woodland survey into 35 counties in addition to the 15 nearing completion and will complete the plantation survey.

THE WOODLAND SURVEY

The objectives of the woodland survey are, briefly, as follows:

Accurate forest cover maps showing location, size, shape, and forest type of all existing woodlands

Reliable information on the quantity and distribution of standing merchantable timber by species and size classes

Reliable knowledge of the density and composition of the growing stock

A determination and analysis of woods management and marketing problems

Such information is essential to an effective program of forest research that will restore Ohio's woodlands to a productive condition.

THE FOREST PLANTATION SURVEY

Approximately 60,000,000 trees have been distributed from the State Forest Nurseries to landowners during the 35 years since this forestry program began. During this period 7,800 different cooperators received trees in various quantities for planting on their land. The reforestation program has grown rapidly during the past 5 years and interest is increasing.

Many problems are involved in planting a field with trees, and these must be answered if this growing interest in planting is to achieve maximum success. The answers to many of these problems lie in the plantings made in the past in this State and elsewhere, and a study of these plantings in detail should yield much valuable information.

As a part of the Ohio Forest Survey, the forest plantation phase undertook to locate and examine all the plantings made with trees from the State Forest Nurseries from 1904 to and including 1938. The information desired was as follows:

Location of each planting made with State trees
Present condition of each planting
- If unsuccessful, reasons for failure if determinable
- If successful, facts regarding—
  - Survival and growth as correlated with site conditions, both at time of planting and at present
  - Sketch map of planting showing location and size, indicating also its subdivision into plots

Information secured will be analyzed and published, first, as separate county reports for limited distribution, later, as a State report for wider distribution.

WHITE PINE BLISTER RUST CONTROL

White pine blister rust control is conducted in Ohio under a cooperative understanding between the Ohio Agricultural Experiment Station, the Ohio Department of Agriculture, and the Bureau of Entomology and Plant Quarantine, United States Department of Agriculture.

White pine blister rust is a fatal disease of white pines caused by a rust fungus requiring the presence of two host plants, white pines and currant and gooseberry bushes (*Ribes*), for the completion of its life cycle. The control of

this forest tree disease consists of the removal of all *Ribes* within infecting distances, usually 900 feet, of white pine stands and the elimination of the cultivated black currant from counties where white pine is grown.

During the past 31 years, the Ohio Division of Forestry has distributed 6,473,000 white pine trees for reforestation purposes to approximately 3,500 landowners, who have planted them on 8,631 acres. There are also 4,200 acres of native white pines, making a total of 12,831 acres. White pine is being used extensively for reforestation because it is a native tree that adapts itself to a variety of conditions, makes rapid growth, produces a high yield of valuable wood, and possesses marked regeneration ability.

Prior to 1930, blister rust had been found on white pines in three Ohio nurseries, and the infected stock had been promptly destroyed. Since 1930, infected white pines have been found in seven northeastern counties—Ashland, Carroll, Cuyahoga, Geauga, Holmes, Knox, and Wayne. Infected *Ribes* have been found in 39 counties.

Surveys show that practically no wild *Ribes* are found in southern Ohio south of U. S. Route 50 from Cincinnati, through Chillicothe, to Marietta. Very few bushes occur south of U. S. Route 40 from Richmond, Indiana, through Columbus, to Zanesville. White pine can safely be planted in southern Ohio with a minimum of blister rust protection cost.

In northern Ohio, *Ribes* occur much more profusely. Care should be taken in the selection of white pine planting sites to avoid concentrations of *Ribes* within 900 feet of the planting.

With labor employed on Federal emergency relief funds, over 71 per cent of the 12,558 acres of white pine have been initially protected. This protection work required the removal of 2,227,702 *Ribes* bushes from 141,167 acres. The largest single year's work was done in 1939, when 74,851 acres were cleared of 1,146,795 *Ribes* bushes. Initial *Ribes* eradication has been completed in the Mohican Valley white pine area, the largest area of native white pine in the State. Most of the largest plantations of white pine have been initially protected.

Ohio nurseries growing white pine in commercial quantities or for reforestation purposes have been given protection.

The following table gives the progress made in blister rust control since 1933 and the present status of the work in the State:

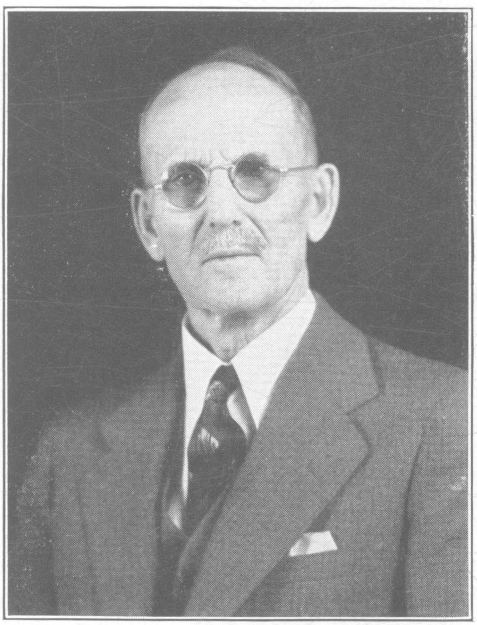
Progress in blister rust control—1933-1939

	Acres of white pine	Acres in control area	Number of *Ribes* removed
Total area	12,558	205,690	.....
Area mapped	10,936	185,795	.....
Area initially protected	8,953	141,167	2,227,702
Area reworked	2,923	25,293	475,964
Area on maintenance*	2,803	33,830	.....
White pine nurseries protected (four)	.....	1,624	59,417
Cultivated black currants destroyed	.....	.....	69,556

*No further *Ribes* eradication work is believed to be needed in the "areas on maintenance." When the present pine stand is harvested, further work may be necessary if the land is continued in pine production.

THE WEATHER

In 1938, a number of changes took place in the climatological work at the Ohio Agricultural Experiment Station. Mr. C. A. Patton, who had been the official weather observer for 44 years, retired from active duty on January 1, after 47 years of continuous service to the Station, a term longer than that served by any other staff member. Mr. Patton's untiring efforts to make and record correct weather observations and his unfailing attention to details brought credit to the Station and warm personal friendship to him from many citizens of the State.



Mr. Charles A. Patton, climatologist for 44 years. Mr. Patton entered the service in March of 1891 and retired from active duty on January 1, 1938.

Prior to 1938, the weather observations obtained were daily maximum and minimum temperature, rain and snowfall in inches, wind velocity and estimated daily average direction, duration of sunshine, and evaporation during the summer months. Special events, such as killing frosts, sleet, hail, and other phenomena were also recorded. Additional equipment added in 1938 has made it possible to melt snow and secure the actual ratio between depth of snow and inches of water when melted. This ratio was assumed to be 10 to 1 prior to this year. Also, with the cooperation of the Climatic Research Center of New

Philadelphia, instruments have been added which make continuous records of rainfall, snowfall, temperature, and humidity, and 15-minute interval records of wind direction and velocity.

Specific weather data for 1938 have already been published in the 1940 May-June Bimonthly Bulletin of the Station, together with similiar data for the year 1939. To keep this weather information up to date, the plan for the future is to publish each year's data in the Bimonthly Bulletin for March and April of the year following instead of in the Annual Report. Long-time average data will be published, probably at 5-year intervals, or oftener if the need arises. Bulletin 608, "Observation of 50 Years of Ohio Weather," carries these data and averages to and including 1937.

PUBLICATIONS

Copies of all Experiment Station publications are available from the Mailing Room of the Ohio Agricultural Experiment Station, Wooster, Ohio.

From June 30, 1938, to July 1, 1939, the Ohio Agricultural Experiment Station Press published 11 bulletins, 6 special circulars, 6 bimonthly bulletins that contained 43 articles, and 52 press bulletins containing 217 press releases.

Staff members had 54 articles published in outside journals.

BULLETINS

No. 594 Cloth Houses. Alex Laurie and Conrad Link. October 1938. 37 pages. 5 figures. 21 tables.

The authors tell the grower where and how to construct his cloth house and how to prepare the soil in it. They discuss the factors influencing growth under cloth and results obtained with a large number of flowers grown in cloth houses. The authors also give experimental results obtained with nursery stock.

595 Potato Flea Beetles and Their Control. Harry L. Gui. October 1938. 29 pages. 3 figures. 33 tables.

This bulletin summarizes the research activities of the Department of Entomology in the potato flea beetle project for the 5-year period from 1930 to 1934 inclusive. The control aspects of the problem have been given the greater emphasis; however, certain imperfectly understood biological phases have received some attention.

596 Winter Injury of Fruit Trees in Ohio. Leon Havis and I. P. Lewis. November 1938. 41 pages. 16 figures.

This bulletin contains a detailed report of the injury to Ohio fruit trees during the winter of 1935-36, as well as brief accounts of other severe winters in which damage is known to have occurred. The authors base the material of the bulletin on information secured from the 18 most severe winters in Ohio during the last 167 years, on a survey of the injury during the winter of 1935-36, and on literature pertaining directly to injury like that observed in Ohio.

597 Local Government in Two Rural Ohio Counties. H. R. Moore. November 1938. 48 pages. 6 figures. 31 tables.

The primary purpose of this bulletin is to present facts on public finance which will aid rural people to understand the developments which are affecting local government at present and possibly shaping its future.

598 Forest Fires in Ohio 1923 to 1935. Bernard E. Leete. December 1938. 54 pages. 20 figures. 35 tables.

Ever since the control of forest fires became a function of the State Division of Forestry, written reports, on standardized forms, setting forth in detail the more important facts concerning each

individual fire, have been kept on file in the southern Ohio office of the Division. From January 1, 1923, to December 31, 1935, 3,034 of these reports accumulated. It has been standard practice since 1927 for the division warden to make a personal investigation on the ground of every fire as soon as possible after its occurrence. The local warden's report is then checked for errors and omissions, and an investigation is made into the cause of the fire. It is the purpose of this publication to subject this information to careful study and analysis.

599 Spraying Program and Pest Control for Fruit Crops. January 1939. 52 pages. 19 figures.

This bulletin discusses the standard spray materials now offered for sale and suggests proper combinations that will control both insects and diseases without causing spray injury to the fruit and foliage. It has been prepared after considerable discussion of the effectiveness and safety of the materials and combinations suggested, and these have been thoroughly tested and approved.

600 Progress of Agricultural Research in Ohio 1937-1938. February 1939. 90 pages. 34 figures. 5 tables.

This publication, the annual report of the Director of the Ohio Agricultural Experiment Station, contains accounts of the experimental work carried on during the year by the Experiment Station Staff, lists the publications of the Ohio Station during the year, and gives the financial statement.

601 The Influence of Position Isomerism in Azo Dyes upon Their Fastness to Light and Washing. Marion E. Griffith and Wallace R. Brode. March 1939. 21 pages. 8 figures. 2 tables.

The work described in this bulletin is part of a general problem dealing with the relationship between the chemical constitution, especially the arrangement of certain groups in the dye molecule, and the properties of the dyestuffs. The properties studied were color, the degree of exhaustion, and the fastness to light and washing.

602 Ohio Agricultural Statistics 1937. Glenn S. Ray, Oakley M. Frost, and P. P. Wallrabenstein. March 1939. 59 pages. 1 figure. 89 tables.

This publication contains the acreage, yield per acre, and production of Ohio's agricultural crops, the numbers of livestock on farms, the amounts of dairy and poultry products produced, and the prices obtained for some of these products when sold. It also contains farm labor supply and demand figures, farm wages, and a statement of the gross cash income of Ohio's agricultural industry from the sale of products and government payments for the years 1910-1938.

603 Timothy Culture. Morgan W. Evans, F. A. Welton, and Robt. M. Salter. May 1939. 54 pages. 6 figures. 28 tables.

The general purpose of the experiments reported in this bulletin is to determine the best cultural practices by which to obtain maximum yields consistent with best quality of hay. The experiments

pertain particularly to methods of seeding and fertilization, time of harvesting, and the effect of the latter on the permanence of stand.

604 The Relationship Between Soil Maintenance and Profitable Farming. F. L. Morison and J. I. Falconer. June 1939. 32 pages. 2 figures. 29 tables.

In the course of a general project undertaken by a committee appointed by the Director of the Ohio Agricultural Experiment Station to determine what adjustments would be necessary in the Ohio cropping system to bring about a farming program that would maintain the productivity of Ohio soils on a long-time basis, it seemed desirable to determine the relationship between farming practices that would maintain the productivity of the soil, and farm income for the year. This bulletin describes the study designed to determine the relationship and presents the results.

SPECIAL CIRCULARS

No. 52 The Vitamin Needs of Farm Animals. Departments of Animal Industry and Dairy Husbandry. August 1938. 12 pages. 2 tables.

In this circular are described the functions of the various vitamins and the symptoms of their deficiencies in farm animals. The vitamin contents of different feeds are listed.

53 Handbook of Experiments in Agronomy. Department of Agronomy. September 1938. 115 pages. 2 figures. 130 tables.

This circular gives the results of tests conducted by agronomists on crop varieties and cultural methods and on fertilizers, lime, manure, and crop rotations. It also serves as a guide to the field experiments carried on by the Department of Agronomy at the Ohio Agricultural Experiment Station.

54 Horticulture at the Ohio Agricultural Experiment Station. Department of Horticulture. September 1938. 64 pages. 16 figures. 32 tables.

This eighth biennial circular of the Horticulture Department of the Ohio Agricultural Experiment Station is designed to bring to the reader and visitor a digest of the research work in progress at the Station in the field of horticulture, and to acquaint him with the most recent information derived from this work.

55 Thorne Wheat. C. A. Lamb. September 1938. 4 pages. 1 figure. 1 table.

Facts concerning the new Thorne wheat are given in this circular.

56 Growing Plants in Nutrient Solution. L. J. Alexander, V. H. Morris, and H. C. Young. May 1939. 17 pages. 5 figures.

Growing plants with their roots in an artificial medium instead of soil is becoming a popular hobby, if not a commercial procedure. The amount of publicity given to this method of growing plants has

led to many fantastic and erroneous notions as to its use. The purpose of this publication is to discuss the merits of the method, including the disadvantages as well as the advantages, for the benefit of those who request information from this Station.

57 The Value of a Milk Fat Substitute—Skimmilk Combination for Raising Bull Calves for Veal and Heifer Calves for Replacements. W. E. Krauss, C. F. Monroe, and C. C. Hayden. June 1939. 4 pages. 1 table.

This circular contains a brief discussion of the possibilities of substituting a commercial product, made largely from beef fat, for whole milk in the feeding of calves.

BIMONTHLY BULLETINS

Vol. XXIII No. 193 July-August, 1938:
- Influence of Residue Color of Bordeaux Mixture on Transpiration in Sun and Shade
- Frost Injury to Raspberry Flower Buds
- No Pruning Compared with Light and Heavy Pruning of Apple Trees
- Basal Metabolism and Food Intake of College Women
- Factors Causing Variations in Milk Returns
- Index Numbers of Production, Prices, and Income

194 September-October, 1938:
- Feeding Value of Hay Crop Silage
- The Value of Milk in the Diet
- Freezing Injury to Strawberry Flower Buds, Flowers, and Young Fruits
- Ohio Wheat Field Insect Survey for 1938
- The Black Wheat-Stem Sawfly
- Effect of Base and Surplus Plans on Volume of Milk Sales by Individual Producers
- Index Numbers of Production, Prices, and Income

195 November-December, 1938:
- The Rate of Seeding Grimm and Common Alfalfa
- Present Cultural Methods in Growing the Spring Greenhouse Tomato Crop in Ohio
- Shelling Percentage and Test Weight per Bushel in Ohio Corn Hybrids
- Palatability of Soybean Meals for Dairy Cows
- Seedless Peaches as a Result of Freezing Injury
- Chemical Conservation of Manure
- Distribution of Late-Crop Ohio Potatoes, 1936 and 1937
- Index Numbers of Production, Prices, and Income
- New Monograph Bulletins
- Staff
- Index

Vol. XXIV No. 196 January-February, 1939:
Station to Give Regular Broadcasts
The Cleaning of Milk Utensils
Preserving Cider by Carbonation
Parity Prices for Ohio Farm Products
Index Numbers of Production, Prices, and Income

197 March-April, 1939:
Evaporation Studies III. Ten Years of Evaporation at Wooster as Measured with Black and White Atmometers
The European Corn Borer and Corn Hybrids
The Care of Layers in Batteries
Tax Delinquent Rural Land Unsuited for Agriculture in Southeastern Ohio
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198 May-June, 1939:
Sun-Coloring Apples
Gravel Culture of Flowering Plants in the Greenhouse
Fattening Steer Calves. Varying the Amounts of Supplement and Molasses
Reducing the Amount of Corn and Increasing the Amount of Legume Hay in Rations for Fattening Yearling Steers, III
Reducing the Corn and Increasing the Hay Content of Rations for Fattening Yearling Steers. Summary of Three Years
Returns per Acre in Cattle Feeding. Medium and Late Varieties of Corn for Silage. Silage versus Limited Amounts of Corn-and-Cob Meal
Old Laying Houses Can Be Modernized
Comparative Evaporation Rates in Normal Forest, Open Park, and Cleared Areas
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JOURNAL ARTICLES

Alexander, L. J. 1939. Recognizing and treating the common greenhouse vegetable diseases and a description of two diseases new to Ohio. Proc. 24th Ann. Meet. Ohio Veg. and Potato Grow. Assoc.: 55-60.

Baver, L. D. 1939. Soil permeability in relation to non-capillary porosity. Proc. Soil Sci. Soc. Amer. 3: 52-56.

————. 1939. Edward Wollny, a pioneer in soil and water conservation research. Proc. Soil Sci. Soc. Amer. 3: 330-333.

———— and Byron Shaw. 1939. Heat conductivity as an index of soil moisture. Jour. Amer. Soc. Agron. 31: 866-891.

Brody, H. W., and N. F. Childers. 1938. The effect of dilute liquid lime-sulphur sprays on the photosynthesis of apple leaves. Proc. Amer. Soc. Hort. Sci. 36: 205-209.

Brown, H. D. 1938. Observations in Europe. Veg. Grow. Assoc. Amer. Ann. Rep.: 169-174.

————, Charles Fitzgerald, and Florence Neuman. 1938. Preserving cider by carbonation. Proc. Amer. Soc. Hort. Sci. 36: 371-373.

————, O. N. Riley, and I. C. Hoffman. 1939. Vegetable variety tests for 1938. Proc. 24th Ann. Meet. Ohio Veg. and Potato Grow. Assoc.: 73-79.

Bushnell, John. 1938. Response of four vegetable crops to phosphate fertilizer in southern Ohio. Proc. Amer. Soc. Hort. Sci. **36**: 515-517.

————. 1939. Fertilizers for early potatoes. Proc. 24th Ann. Meet. Ohio Veg. and Potato Grow. Assoc.: 9-14.

————. 1939. Fertilizers for early tomatoes. Proc. 24th Ann. Meet. Ohio Veg. and Potato Grow. Assoc.: 78-86.

Carroll, J. C., and F. A. Welton. 1939. Effect of heavy and late applications of nitrogenous fertilizer on the cold resistance of Kentucky bluegrass. Plant Physiol. **14**: 297-308.

Chadwick, L. C., and D. C. Kiplinger. 1938. The effect of synthetic growth substances on the rooting and subsequent growth of ornamental plants. Proc. Amer. Soc. Hort. Sci. **36**: 809-816.

Cutright, C. R., and M. A. Vogel. 1939. Recent experiments in codling moth control. Ohio State Hort. Soc. Proc. 72nd Ann. Meet.: 32-39.

Edgington, B. H., W. E. Krauss, C. F. Monroe, and C. C. Hayden. 1939. The effect of ultraviolet radiation of cows on their agglutinin titer for Bang's disease. Jour. Dairy Sci. **22**: 444-445.

———— and A. F. Schalk. 1939. Some tests with crystal violet vaccine for prevention of hog cholera. Jour. Amer. Vet. Med. Assoc. N. S. **47**: 5: 501-508.

Ellenwood, C. W. 1939. Growing fruit in grass mulch. Conn. Pom. Soc. Rep. 48th Ann. Meet.: 39-50.

————. 1939. Sun coloring of apples. Conn. Pom. Soc. Rep. 48th Ann. Meet.: 130-138.

————. 1939. Sun coloring of apples. Ohio State Hort. Soc. Proc. 72nd Ann. Meet.: 110-118.

Evans, M. W. 1939. Relation of latitude to certain phases of the growth of timothy. Amer. Jour. Bot. **26**: 212-218.

Gerlaugh, Paul, and C. W. Gay. 1938. Reducing the corn and increasing the hay content of rations for fattening yearling steers. Rec. of Proc. 31st Ann. Meet. Amer. Soc. Animal Prod.: 25-27.

Gourley, J. H. 1939. Some soil studies and the mulch system of orcharding. Trans. Ill. State Hort. Soc. **72**: 234-243.

Gui, Harry L. 1939. The residue problem in cabbage worm control. Proc. 24th Ann. Meet. Ohio Veg. and Potato Grow. Assoc.: 92-97.

Hauck, C. W. 1939. Factors affecting marketability of Ohio potatoes. Proc. 24th Ann. Meet. Ohio Veg. and Potato Grow. Assoc.: 30-34.

————. 1939. Damage to Ohio potatoes by digging machinery. Proc. 24th Ann. Meet. Ohio Veg. and Potato Grow. Assoc.: 34-42.

Havis, Leon. 1938. Peach tree root distribution. Ecology **19**: 3: 454-462.

————. 1938. Influence of certain cultural systems upon root distribution of black raspberries. Proc. Amer. Soc. Hort. Sci. **36**: 478-480.

————. 1939. Anatomy of the hypocotyl and roots of *Daucus carota*. Jour. Agr. Res. **58**: 8: 557-564.

————. 1939. Pointers on cultural practices with strawberries and raspberries. Ohio State Hort. Soc. Proc. 72nd Ann. Meet.: 63-67.

Hoffman, I. C. 1938. Present cultural methods in growing the spring greenhouse tomato crop in Ohio. Veg. Grow. Assoc. Amer. Ann. Rep.: 88-100.

————. 1939. The minor element problem in Ohio greenhouses. Proc. 24th Ann. Meet. Ohio Veg. and Potato Grow. Assoc.: 51-55.

———. 1939. Injuries following greenhouse soil sterilization, causes and control. Proc. 24th Ann. Meet. Ohio Veg. and Potato Grow. Assoc.: 60-64.

Howlett, F. S. 1939. Correcting biennial bearing with apples. Ohio State Hort. Soc. Proc. 72nd Ann. Meet.: 80-87.

———. 1939. The modification of flower structure by environment in varieties of *Lycopersicum esculentum*. Jour. Agr. Res. 58: 79-117.

Knoop, C. E., W. E. Krauss, and C. C. Hayden. 1939. Magnesium and vitamin D relationships in calves fed mineralized milk. Jour. Dairy Sci. 22: 283-289.

Krauss, W. E., C. F. Monroe, C. C. Hayden, and B. H. Edgington. 1939. The effect of ultraviolet radiation on milk production. Jour. Dairy Sci. 22: 440-441.

Laurie, Alex, and Paul F. Bobula. 1938. A study of flowering rose shoots with reference to flower-bud differentiation. Proc. Amer. Soc. Hort. Sci. 36: 767-768.

——— and J. F. Fueglein. 1938. Biological activity in steam sterilized soils in the greenhouse. Proc. Amer. Soc. Hort. Sci. 36: 837-840.

——— and Arnold Wagner. 1938. Gravel and cinder culture of greenhouse flowering plants. Proc. Amer. Soc. Hort. Sci. 36: 769-772.

McKay, Hughina, and Mary Brown Patton. 1938. Food intake of freshman college women. Jour. Home Economics 30: 583.

Monroe, C. F. 1939. A study of the pH values of the ingesta of the bovine rumen. Jour. Dairy Sci. 22: 12: 983-991.

——— and A. E. Perkins. 1939. A rapid method for determining moisture in roughages. Jour. Dairy Sci. 22: 1: 37-39.

Morgan, M. F., J. H. Gourley, and J. K. Ableiter. 1938. The soil requirements of economic plants. U. S. Dept. Agr. Yearbook of Agriculture: 753-776.

Petzel, Florence, E. Phelps, A. Loring, and E. Neilson. 1939. A study of certain factors related to consumers' choice in purchase of 'silk' street dresses and silk yard goods. Jour. Home Economics 31: 393-398.

Robison, W. L. 1938. Soybeans and soybean oil meal for pigs. Proc. 18th Ann. Meet. Amer. Soybean Assoc.: 18-22.

———. 1939. Rations for swine. Proc. Ohio State Vet. Med. Assoc.: 88-95.

Salter, R. M. 1938. Methods of applying fertilizers. U. S. Dept. Agr. Yearbook of Agriculture: 546-562.

——— and C. J. Schollenberger. 1938. Farm manure. U. S. Dept. Agr. Yearbook of Agriculture: 445-461.

Silver, E. A. 1938. Analysis of agricultural engineering research. Agr. Eng. 19: 9: 405.

Sutton, T. S. 1939. Anatomical and physiological changes in the pituitary gland in vitamin A deficiency. Jour. Dairy Sci. XXII: 458.

——— and B. J. Brief. 1939. Physiological changes in the anterior hypophysis of vitamin A deficient rats. Endocrinology 25: 302.

Tilford, Paul E. 1938. Effect of some synthetic growth substances on root development of transplanted trees. 14th Nat. Shade Tree Conf., Proc. Ann. Meet.: 51-58.

Welton, F. A., and J. C. Carroll. 1938. Crabgrass in relation to arsenicals. Jour. Amer. Soc. Agron. 30: 816-826.

Wilson, J. D. 1939. New equipment and new materials for controlling vegetable diseases. Proc. Ohio Veg. and Potato Grow. Assoc. 24: 110-134.

FINANCIAL STATEMENT

July 1, 1938, to June 30, 1939

Consolidated Statement

ASSETS AND LIABILITIES

ASSETS

Current assets	$ 118,490.60	
Contingent assets	268,217.47	
Land	693,479.26	
Land improvements	70,025.34	
Buildings	668,723.67	
Departmental equipment	585,792.85	
Total assets		$2,404,729.19

LIABILITIES

Capital account	$2,136,511.72	
Special State appropriations	268,217.47	
Total liabilities		$2,404,729.19

INCOME AND EXPENDITURES

INCOME

Cash balance, July 1, 1938	116,825.14	
Appropriations by State Legislature	372,279.92	
Appropriations from U. S. Government	177,315.92	
Sale of produce, etc.	101,244.30	
Total income		$ 767,665.28
Less funds paid to State Treasurer and not available for use by the Station		85.10
Total available income		$ 767,580.18

EXPENDITURES

Salaries	336,613.31	
Employees and extra labor	143,432.88	
Stationery and office supplies	3,203.21	
Incidentals	4,693.82	
Laboratory supplies	6,427.90	
Materials and general supplies	50,603.99	
Repairs to equipment	10,701.58	
Telephone and telegraph	2,287.01	
Freight, express, and cartage	2,732.30	
Travel	6,213.28	
Feed	28,594.69	
Fertilizers	1,906.94	
Apparatus	6,780.61	
Furniture and fixtures	1,497.47	
Machinery, tools, etc.	16,120.31	
Library	593.14	
Livestock	23,549.92	
Land	2,210.50	
Land improvements	394.73	
Buildings	531.99	
Total expenditures		$ 649,089.58
By balance forward		118,490.60
Total		$ 767,580.18

Respectfully submitted,
W. H. Kramer, Bursar

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